FOOD MANUFACTURE

PUBLISHERS: LEONARD HILL LIMITED, 17, STRATFORD PLACE, LONDON, W.1 APRIL 5, 1940

FOR INCREASED WAR OUTPUT

SPECIFY
"BENNIS" STOKERS
AS SUPPLIED
TO THE MOST PROMINENT
FOOD MANUFACTURERS

"Bennis" Coking Stokers
at Nottingham Co-operative
Dairy, Meadow Lane.

BENNIS COMBUSTION LTD
LITTLE HULTON, BOLTON + 28 VICTORIA ST. LONDON, S.W.1

FOOD SUPPLIES— *URGENT*

Since the great Evacuation, speed and transport have become even greater problems of food supply.

MONO CONTAINERS help the producer to meet them in two ways:

1. Because deliveries are available and to individual requirements. *MONO keep their word!*
2. Because the containers themselves are light, easy to store, pack and handle; and they won't be damaged on the road.

Switch to MONO CONTAINERS, and rest assured that your consignments will leave to time, arrive safely, and be in the form that the general public appreciate.

★ LIGHTWEIGHT

★ LABOUR-SAVING

★ WASTE-PROOF

MONO *Containers*

MONO CONTAINERS LIMITED · PARK ROYAL · LONDON · N · W · 10

Index to Advertisers, see pages iv, vi, viii & x

A JOURNAL DEVOTED TO THE PRODUCTION AND MANUFACTURE OF ALL EDIBLE COMMODITIES INVOLVING A PROCESS OF MANUFACTURE.

FOOD MANUFACTURE

Incorporating Canning, Packing and Preserving.

VOLUME . . . XV

NUMBER 4

APRIL 5, 1940

Boiler House Number

CONTENTS

	PAGE
Editorial	81
British Thermal Units to Kilowatts. *H. C. Appleby*	85
Steam Trap Capacity. *R. E. Ashton*	92
The Adjustment of Reaction of Terminal Residues of Baking Powders. *Simon Mendelsohn, F.A.I.C.* . . .	94
Food Poisoning. Part VII. *Elliot B. Dewberry, M.R.I.P.H., M.R.San.I.* .	97
Payment of Wages in Kind. *"Barrister-at-Law"*	101
Coal in the Food Industry. *S. J. Eardley* . .	102
Correspondence	105
Boiler House : Plant and Equipment. *A Symposium*	106
Information and Advice	114

Published on the first Friday of every month by Leonard Hill Limited, 17, Stratford Place, London, W. 1. Telephone: Mayfair 7383 (Private Branch Exchange). Annual Subscription, 10s.; Abroad, 12s. 6d.; Single copies, 1s.

The Editor will be glad to consider contributions from those engaged in the Food Industry. Articles intended for publication should be of a practical nature and accompanied by photographs or drawings when possible.

for

FOOD STORAGE AND TRANSPORT

CAMBRIDGE INSTRUMENTS
for
FOOD STORAGE & TRANSPORT
APPROVED BY THE BRITISH ASSOCIATION OF REFRIGERATION FOR FOOD TRANSPORT
EGGS FRUIT MEAT FISH OR CEREALS ON LAND OR SEA
CAMBRIDGE INSTRUMENT COMPANY LTD.
13 GROSVENOR PLACE, LONDON, S.W.1
6436

CAMBRIDGE INSTRUMENTS

FOR THE PRESERVATION OF

EGGS
FRUIT
MEAT
FISH
OR
CEREALS

ON LAND OR AT SEA

THIS NEW FOLDER 66-R

contains details of several instruments for measuring TEMPERATURE in Food Stores, and GAS ANALYSERS for the gas storage, on land or on board ship. It includes a table giving the most effective storage conditions for various food products.

MAY WE SEND YOU A COPY?

CAMBRIDGE

INSTRUMENT CO LTD

WORKS:— LONDON & CAMBRIDGE *Head Office & Showrooms*:— 13 GROSVENOR PLACE LONDON, S.W. 1.

Facing first page of Editorial

FOOD MANUFACTURE

Vol. XV, No. 4 April 5, 1940

The Boiler House

THE PROMINENCE given to boiler-house matters in this issue needs no apology. The necessity for the greatest efficiency and the exercise of maximum economy has never been greater than it is to-day, not only in large but in small plants.

There may be a tendency on the part of the smaller food manufacturer to discount economies in fuel as being something not warranting the expense of additional equipment, although we trust that there are not so very many concerns in which, as one of our contributors says, "there is no method at all, the only measurement that is ever taken being the weighing of the fuel as it enters the factory in order to check up on the bill which will be sent in by the people who supply the coal . . . the boiler-house staff being left to grope in the dark". How and where economies may be effected are indicated in this special number.

Bread Staling

The staling of bread has received a great amount of attention in every country where wheaten bread is eaten. The loss due to staling is a very serious burden, and if a remedy could be found it would have a profound effect on the economics of the baking trade. Any information on the subject is, therefore, of great importance, and Cathcart, of the American Institute of Baking at Chicago, has rendered a valuable service to the trade by his extremely exhaustive review of the progress in research on bread staling, published in the current issue of *Cereal Chemistry*.

After reviewing the published work, he concludes that a palatable loaf of good keeping qualities requires a flour with a high quality gluten and liberal amounts of milk shortening and sugar (preferably syrup). Only normal amounts of salt and yeast should be used, but malt extract and a moisture-retaining agent such as gelatinised starch are useful. The dough should be medium slack, made by high-speed mixing. After baking the bread should be cooled rapidly and wrapped after adequate cooling. A very useful section of the paper is a bibliography containing 44 references to original papers on the subject.

Yeast Storage

It is not always possible to have freshly produced compressed yeast delivered daily to bakeries. As time goes on it may become increasingly difficult to obtain regular supplies, and it is, therefore, essential to store yeast for a period before use. The problem then arises as to what temperature should be selected for storage, and, if the yeast is frozen, what is the best procedure for getting it back again into a correct condition for baking. Some very interesting work has recently been done at the U.S. Department of Agriculture on this question, and it has been shown that compressed yeast packed with dry ice for two days deteriorated more rapidly than fresh yeast stored for the same length of time and at the same temperature. The frozen yeast became mushy on thawing and was difficult to handle. Of the storage temperatures used, 30° F. is considered the most suitable, since the yeast does not freeze at that temperature and retains its normal consistency. Bread made from this yeast fully equalled that from yeast stored at any other temperature.

Food Control and Weights and Measures

The recently enacted Sugar (Weights and Measures) Order looks like producing a sharp conflict between the Inspectors of Weights and Measures and the Food Control Committees. The Council of the Incorporated Society of Inspectors of Weights and Measures pointed out to the Ministry of Food that it was both desirable and expedient that all Inspectors of Weights and Measures should have some hand in the adminis-

tration of the Food Orders, but they do not seem to have derived much satisfaction from the Ministry's reply. The February issue of the Society's monthly review devotes much space to the subject, and the leading article states: " . . . The administration of the Order is the sole prerogative of the Food Control Committees. The Order does not specifically withdraw sugar from the scope of the Sale of Food (Weights and Measures) Act, and it is a matter of some concern that separate legislation governing the sale of sugar by weight should be administered by different authorities ". It also goes on to state that " No mention is made therein of safeguards to traders, and in any action that might be taken by a Food Control Committee none of the defences provided by the Sale of Food (Weights and Measures) Act will be available to the defendant ". The position of traders is made complicated enough by the Sale of Food Act, but it appears as if it will be considerably worse under the new Order.

Keeping Quality of Flour

War conditions have brought a number of problems into prominence which, in normal times, were only of minor importance. One of these is the length of time flour will keep fresh. Security stocks have been accumulated by millers and bakers, and many housewives have been encouraged to keep larger stocks than they would in peace time. The problem is how long will the flour keep fresh? Much depends on the moisture content of the flour (a dry flour will keep longer than a damp one) and the conditions of storage.

In connection with the keeping qualities of flour, some recent work by Shellenberger indicates that malted oat flour decreases the rate of deterioration of flour during a storage period of several months. Oatmeal has been shown to be of value in preventing rancidity in fats, so it was to be expected that the malted oat flour would have some influence on the keeping properties of flour. In addition to the slowing up of deterioration, the malted oat flour gradually enhances the diastatic activity of wheat flour, which, in itself, is a distinct advantage.

Sausage Meat

Some interesting work has recently been published in an Italian journal on the detection of either mutton or beef in mixtures of the two. The basis of the investigation was the precipitation method. Sera from mutton and beef were purified and their specificity increased by the " saturation " process devised by Mazzaracchio and Rosa. These sera were then used in testing antigens prepared from a range of mixtures of the two meats. Sharp positive reactions were obtained with as low as 5 per cent. of mutton or beef in the mixture, if the appropriate precipatory serum was used. The results were not influenced if the meat had been stored for nine months.

Good results have been obtained by these sera methods with other meat mixtures, and it appears that if an albuminoidal extract can be prepared from a sausage product, it is possible to distinguish the kinds of meat present, even though these may be derived from the same zoological family.

Banana Bread

There has recently been some talk about the use of banana flour in bread-making. This has arisen from the announcement that a plantation manager in Cuba has discovered a method for making meal from bananas. His idea was to incorporate it in a bread dough and thus use up the surplus crops of bananas. This idea, as *Milling* points out, is not new, and banana meal has been made in South America for years. We also have discussed it with a man who ate banana bread in Africa over forty years ago. As a substitute for flour in this country during war-time banana flour is not likely to attract much attention. Bananas, or the meal, would be just as difficult to transport as wheat, and there is an abundant supply of wheat in the world. Experiments have, however, shown that they can be used in flour confectionery, and, on account of the sugar content, would bring about an economy in sugar. Cakes made with pulped banana or banana meal have a pleasant flavour and keep moist a long time.

Transmission of T.B.

A great deal of attention has been devoted to the transmission of tuberculosis from cattle to man, but the reverse possibility that cattle may become infected by man has not had the same interest displayed in it, and to many people it may be a new conception. The transmission of disease to cattle by their attendants is very important and may have far-reaching effects.

In our June issue last year we referred to the infection of cattle with scarlet fever by a milkmaid. Recently Nielsen and Plum, of the State Veterinary Serum Laboratory of Copenhagen, have recorded instances of infection of cattle by tuberculous persons employed on farms in Denmark. Farms which had been free from tuberculin reactors revealed, without warning, a large number of posi-

tive reactors, and this suggested the sudden appearance of an unexpected focus of infection in their midst.

One herd which had been free from tuberculosis since 1932 suddenly yielded 19 positive reactors out of 29 cattle. On investigation a farm hand was discovered who had been previously vigorous and apparently healthy, but who was later admitted to hospital and subsequently transferred to a sanatorium.

Altogether 17 farms were dealt with, and in 13 of these a worker suffering from tuberculosis was found from whom the bovine strain of the tubercle bacillus was isolated. In one instance a human-type strain was obtained from a worker. Other investigators, such as Griffith in 1913 and Reid in 1939, have recorded cases of cattle infected with the human type of bacillus.

It seems to have been settled beyond doubt that cattle can transfer infection to man by contact, and the work described above seems to indicate that the reverse process can also occur.

Flour Granularity

The present methods for determining the granulation of flour are far from satisfactory, and the subject is very important as the granularity of flour has an influence on baking qualities. In a paper by Kent-Jones, Richardson, and Spalding, in the *Journal of the Society of Chemical Industry*, the authors have discussed some of the principal difficulties encountered in attempting to make and record such measurements, and also they have suggested a method by which the percentage masses of the particles between various sizes (in steps of 10μ) can be recorded. It is an adaptation of the sedimentation methods that have been recommended and satisfactorily used in measuring the particle sizes of soils, and it depends on the application of Stokes' law. The decrease in the cloudiness of a dilute petrol suspension of flour is measured at a fixed depth by the increase in the intensity of a beam of light which falls on to a photo-electric cell and is recorded by a rise in the galvanometer reading. By assuming that under the conditions of the experiments Stokes' law is valid (and this assumption seems justifiable), an actual record of the distribution of particle size between normal limits can be obtained. This is very important to millers. In the normal bakers' flour about half of the particles are larger than 45μ and the other half less. Strong flour made from hard wheat is coarser, but soft flours specially manufactured for cakes often show less than 10 per cent. particles larger than 45μ—in practice the bulk of the flour is between 15 and 25μ. The method can be applied to the various flour streams made in the mill in the process of manufacturing commercially sold flours, and may indicate to the miller an abnormality in working which he might otherwise have missed.

The Truck Acts Case Ends

After a weary journey through the various courts of this country, the case under the Truck Act of 1931 (discussed by Barrister-at-Law in this issue), which started in 1938, came to an end in the House of Lords on February 8, 1940. It was a curious case which might form an awkward precedent affecting many firms. A packer was paid 53s. a week and given dinner and tea (supposed to be equivalent to 10s. a week). When he was on holiday he was given the 10s. in cash. In 1938 he sued his employers for £397 10s.—*i.e.*, 10s. a week for 15 years—relying on the Truck Act, 1931. The judge gave judgment for the plaintiff. The defendants appealed, relying on section 23 of the Truck Act, 1831, and won the appeal. Now the House of Lords have allowed the plaintiff's appeal by four to one. This difference of opinion among the learned judges indicates that there is a considerable element of doubt about the matter, and Sir J. Mellor asked the Home Secretary whether, in order to prevent widespread litigation of an unworthy character, the Government proposed to introduce amending legislation. He received an evasive and completely unsatisfactory reply from Sir John Anderson.

British Investments

Lord Luke, presiding at the Bovril annual meeting, pointed out that there was no Government Department and no Minister whose special duty was to look after this country's £1,100,000,000 investments in South America. To illustrate the difficulties of British companies operating overseas, he cited the Argentine Estates of Bovril, Ltd., which owned a great meat works at Santa Elena, Entre Rios. The company was only able to meet its Debenture interest and about half the dividend on its £500,000 Preference shares, nothing being available for £700,000 of Ordinary and Deferred share capital. A Minister whose business it was to look after British companies overseas could easily have put this right by insisting that this *frigorifico* should have at least 1 per cent. of the quota to ship meat into England, a privilege enjoyed by a

dozen foreign *frigorificos* in South America. British Government departments had known of this for years, but there was no record of their ever giving any help. He specially made this point not for one company alone but for all British companies working overseas.

Sausage Grading

After considerable delay and much speculation, a decision has been taken on the sausage question. Grading is on right lines—both meat content and prices are fixed. We think, however, that the grading method leaves something to be desired. Grade A is simple enough, the meat content being no less than 70 per cent. by weight. Grade B comprises a range between 45 and 70 per cent.—a 25 per cent. margin—and Grade C a 15 per cent. margin between 30 and 45 per cent. meat.

With Grade B the consumer apparently will pay 1s. 4d. per pound whether the sausage contains 45 per cent. or 69 per cent. of meat. We may be dense, but we cannot quite understand why the grades should have such wide limits. It cannot be to allow the manufacturer a margin for unavoidable error, otherwise the limits would have been the same for Grades B and C. In any case, there are no technical difficulties in the manufacture which prevent a sausage being made closely approximating to a given composition. From May 1 it will not be permitted to sell sausages without an indication of the meat content. This regulation will apparently allow us to select what grade of grade we shall buy!

There remains the qualitative aspect—what exactly is the "meat" contained in the sausage? However, perhaps we are asking too much all at once. The fact remains that for the first time in history there is some kind of regulation governing the composition of the sausage, and doubtless no one will welcome it more than the manufacturer himself.

Mar'j'arine?

We have received an interesting little booklet, issued by the makers of Stork Margarine, entitled *Margarine, Its History and Nourishing Values*, which tells quite a lot about this article of diet. It also "gives the answer" to the vexed question of its pronunciation. The "g" must be hard, as in the name "Margaret", because it comes from the Greek *margarites*, meaning a pearl, to which the product apparently has a resemblance at one stage of its manufacture. That is the scholars' verdict. But the popular or "folk" pronunciation has the soft "g", and this is conceded without censure by the Oxford English Dictionary, Wyld's Universal, and Chambers.

In the early days the hard "g" was rarely heard, perhaps because Greek scholars did not use either the word or the substance.

Facility for compromise is supposed to be one of the characteristics of the English people, so the suggestion which was recently put forward may be a good one—to use the hard "g" in cold weather and the soft one in the summer.

Eels

"The eel is our commonest freshwater fish. In food value it rivals the salmon and in flavour the sole." Thus a Ministry of Agriculture announcement. Rather strange, isn't it, that while this is news to one part of the community it is a commonplace to the other part! East of Aldgate Pump such an announcement would be greeted by the observation, "You're telling me!"

The Ministry points out that we have been spending nearly £200,000 per annum on foreign eels while our native lakes and ponds teem with them. The Fisheries Department of the same Ministry is doing all it can to re-establish the industry, particularly by encouraging professional fishermen to fish for eels and by demonstrating more efficient methods. They can be caught by set nets or baited traps or by "bobbing".

Apropos methods, we do not know whether the *Ingoldsby Legends* are read nowadays, but those who know them will remember the exclamation of the Lady Jane (who was tall and slim and fair) when she had eaten the eels which had been extracted from the dead body of her spouse, Sir Thomas the Good (of whom she was "uncommonly fond") after he had been taken from the pond:

> "*They're a fish too of which I'm uncommonly fond*
> *Go—pop Sir Thomas again in the pond—*
> *Poor dear! he'll catch us some more!*"

Which among other things goes to show that eels were appreciated by the upper classes round about the "roaring forties".

The Ministry does not suggest recipes for the cooking of the delicacy, and here perhaps Thomas Ingoldsby's "moral" to the tale of the Knight and the Lady may be useful:

> "*One more piece of advice and I close my appeals*
> *That is—if you chance to be partial to eels*
> *Then*—crede experto—*trust one who has tried—*
> *Have them spitch-cock'd—or stewed—they're too oily when fried!*"

BRITISH THERMAL UNITS TO KILOWATTS

Many food manufacturers produce their own electric current and will be interested in this description of the scientific operation of a modern power house by

H. C. APPLEBY

SOME of the larger factories manufacturing food, who use large quantities of steam for processing purposes and also produce their own power, have followed the example of the electricity undertakings in paying meticulous attention to all details which affect the consumption of coal used for the generation of steam. Probably the chief reason for this is that if the public supply authorities could not produce electrical energy sufficiently cheaply to sell at a profit, they would, so far as power supply to industrial concerns is concerned, soon be out of business. This profit, let it be remembered, has to cover one cost additional to those met by factory owners, insomuch as the current once having been generated, has to be transmitted through expensive cables or overhead lines. It is obvious, then, that improvement in design of new plant, and improved technique in the operation of all plant is, or should be, closely watched by factory owners.

Figures prove that where steam required for processing has been utilised to drive a turbine or engine to supply power, before delivery to the processing plant, the higher thermal efficiency and lower coal cost are respectively higher and lower than any power station, which completely condenses the exhaust steam from its turbines or engines, can hope to produce.

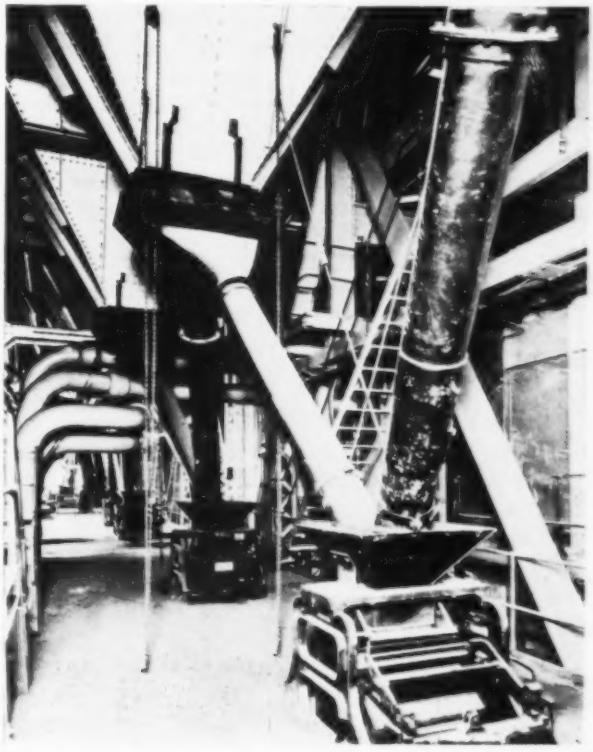
Scientific Operation

Details will be given, in this article, of the scientific operation of a modern power plant which does not run on any form of back pressure system, of which there are many thousands in Britain. In many factories there is room for much improved methods of coal burning. Indeed, it can be safely stated that some have practically no method at all, the only measurement that is ever taken (and science calls for much measurement) being the weighing of the fuel as it enters the factory in order to check up on the bill which will be sent in by the people who supply the coal. The firemen are supplied with boilers and pumps, water and coal, and are instructed to throw coal into the boiler-furnaces until steam at the required pressure is indicated on the pressure gauge. But so far as provision for making the steam at the lowest cost for fuel is concerned, no aids to secure this result are provided, the boiler-house staff being left to grope in the dark.

Before describing how an up-to-date boiler-house is run, it is desirable that it be made perfectly clear that with modern boiler practice 85 per cent. efficiency should always be obtained with boilers carrying a normal load, and it might be added that 90 per cent. has been secured, but this is not generally achieved, as it is unfortunately the fact that more often figures of 50 to 60 per cent. prevail.

Loss of Heat

The main reason for this, in the writer's opinion, is that many factory executives have yet to learn that the burning of coal in such a way as to avoid unnecessary loss of heat is a complex scientific problem; difficult but not beyond achievement. The use of the laboratory to con-



Automatic coal weighers dealing with coal from main bunkers to boilers.

trol all stages of manufacture of a given production is freely acknowledged, but the introduction of similar control in the boiler-house has, as yet, not been generally recognised as being necessary. Engineers like to think of the boiler-house as a self-contained factory, the raw materials being coal and water, while the finished product, to be sold to other parts of the factory where it may be required, is steam. The chemist must work closely with the engineer in order to eliminate waste at every possible point in the boiler-house, and there is required just as much careful attention to laboratory technique in connection with boiler-house control as is applied to work in connection with other parts of the factory.

Analytical Control

The successful burning of coal can be checked to such an extent that data can be secured which will demonstrate whether the heat contained in the steam discharged from the boilers nearly balances the heat put into the boiler furnaces in the form of coal. It is obvious then that these particulars must be available for comparative purposes. In order to know the amount of heat put into the furnace it is necessary that the heating value of each pound of coal burnt is known. This is done by obtaining an *average* sample of the coal, the calorific value of which is ascertained in the laboratory.

There are many efficient types of calorimeter available to the fuel chemist and the knowledge of the calorific value of the coal used is a *sine qua non* in the boiler-house.

The following data must be ascertained:

(*a*) The heat value of the fuel put into the furnace.

(*b*) The heat value of the steam (and also the pressure) delivered.

The main object in modern boiler-house practice is information as to how many lbs. of water are evaporated per lb. of fuel consumed, but with the heat value of the coal known, and also the heat content of the steam, a heat balance is drawn up, which shows how much of the heat from the coal has been transferred to the steam and also where losses have been sustained. When *avoidable* losses occurs it is highly desirable that it should be indicated at once, and suitable action taken to eliminate it immediately.

Modern Water-Tube Boilers

The modern water-tube boiler is a "tricky" piece of plant composed of hundreds of parts encased in a steel box, which, from the outside, it closely resembles, but inside that box are scores of tubes, some for water circulation, some for steam circulation, as well as super-heaters and economisers, together with the travelling grate which carries the burning fuel. In order to ascertain the heat in the furnace itself, it is usual occasionally to measure this temperature by means of an optical pyrometer focussed through a sight-hole in the side wall of the furnace. As the hot gases pass through the banks of water-tubes heat is taken up by the water in them, as also is the case with steam in the super-heaters, water in the economisers, and finally air in the air heaters supplying secondary air to the furnaces. An endeavour is always made to secure maximum heat absorption at each of these various stages, and for this purpose pyrometers or thermo-couples are installed at each stage of the hot gas circuit. These are connected to either (or both) indicating and recording instruments assembled on a panel (together with others which are referred to later in this article) placed near the front of the boiler, the indicating instruments having large dials easily read by the firemen. One or two reasons for installing these temperature indicators and recorders may be usefully given. After a boiler has been out of commission for repairs and cleaning, the boiler's surfaces, both internal and external, should be almost bare metal, the outside surfaces of the drums and the tubes having been scraped with wire brushes, the inside of the drums and the inner surfaces of the tubes having had all scale removed by mechanical means. Shortly after the boiler has been put into service, soot particles form a crust upon the tubes, which, if allowed to accumulate, will prevent much of the heat contained in the gases being absorbed by the water in the tubes or by the steam in the super-heater, or by the water and steam in the drums. If steps are not taken to prevent this happening the result will be that much heat will go up the stack and be wasted.

Soot Deposits

The Engineering Department of the University of Illinois conducted a series of tests to determine the extent of the losses due to soot deposits. The results are tabulated below:

Three series of tests were made, each covering a period of five days, as follows:

First series—Soot is allowed to remain on tubes.
Second series—Tubes cleaned each morning.
Third series—Soot allowed to remain on tubes.

	First Series.	*Second Series.*	*Third Series.*
Equivalent evaporation from and at 212° F. per lb. of dry coal	6·20	7·04	6·23
Dry coal consumed per sq. ft. of grate surface per hour ..	13·4	9·09	13·40
Temperature of escaping gases	627° F.	546° F.	698° F.
Increase in evaporation due to clean surfaces	13·0 per cent.		
Decrease in coal burnt per sq. ft. of grate per hour due to clean surfaces	32·16 ,, ,,		
Lowering of stack temperature due to clean surfaces	17·59 ,, ,,		

From the preceding data it is plainly evident that the daily cleaning of soot deposits from the boiler heating surfaces is a necessity, if efficiency is to be maintained and economy of coal secured. While it would probably be sufficient to install reliable soot blowers and at set times to blow the soot from the tubes, indicating pyrometers give warning when this is necessary, and recording pyrometers supply the controlling engineer with information on what has actually been occurring within the boiler at any time, day or night.

Another Source of Loss

There is another possible source of loss about which the pyrometer warns the engineer. The path round which

the gases are guided inside the boiler is formed by baffles laid on the water-tubes, these being made of high grade fire-bricks resting on the tubes, or of plastic refractory material plastered on to them and allowed to become hard before recommissioning the boiler. This baffling makes a path in the form of a large "S," and so long as it remains intact the gases *must* travel that path, and in traversing the whole of the heating surface give up heat units to the contents of the boiler. But, should either baffles or refractory material perish or fall, the gases take the line of least resistance and pass through the gaps which have been created and retain heat which would have been accepted by the boiler if the gases had travelled their pre-arranged path. When this does happen the indicator and recorder at once warn the engineer, who at all times is keen on repairing the trouble as soon as possible, in order to secure maximum transfer of heat to his boiler, and minimum loss up the chimney.

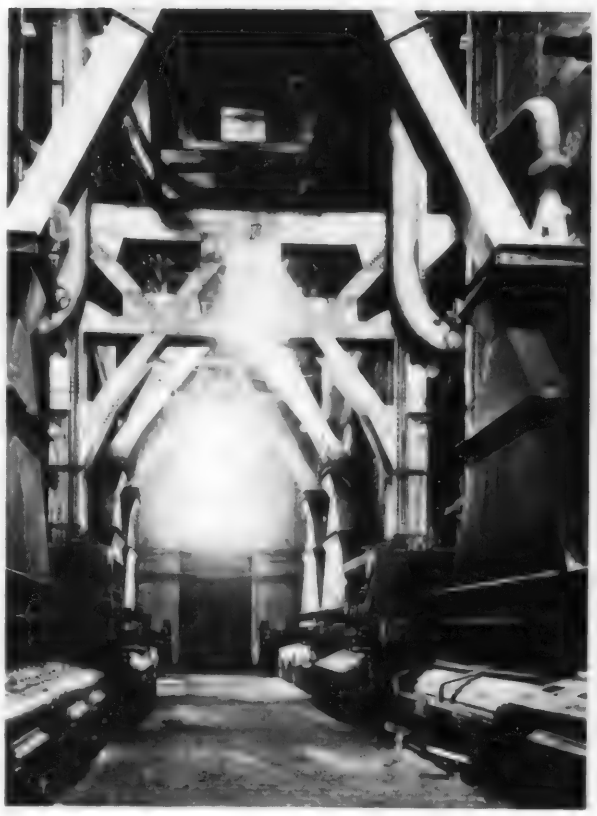
Fuel Weighing

The weight of the fuel actually put into the furnace and the amount of steam generated by the boiler must be known by the operating engineers, and, indeed, it is satisfactory to note that in some of the modern boiler-houses a keen and healthy rivalry is continuously carried on by the boiler-house teams of each shift who endeavour to get the best "lbs. of water evaporated per lb. of fuel" figure for their own particular working period or shift. It is not considered sufficient merely to weigh the coal as delivered to stock, but all up-to-date plants are fitted with actual weighing machines between the overhead bunkers and the bunker at the front of the furnace. These machines are entirely automatic in action, and an integrating device is fitted so that at any given minute the amount of coal that has been sent to the individual furnaces can be known, from the time when the integrator was previously read.

If the total lbs. weight of coal supplied over a given period of time is known, it is only necessary to have a similar indication of the water evaporated over the same period to make provision for a constant check on boiler performance, and actually to run under what are practically "test conditions" at all times, day and night, month in and month out, which is what the keen boiler-house engineer seeks to do.

Steam Meters

In the larger boiler-houses the "water evaporated" is secured from a steam-meter fitted in the discharge steam pipe from each boiler, and not only does this record the total amount of steam passed during any period, but it also indicates on a large-scale instrument what amount of steam is actually passing from the boiler at the time the indicator is observed, this particular instrument being known as a load indicator. By using the knowledge this supplies, the boiler-house engineer is able to put in or take out of commission boilers which are required or are not required, without causing big variations in the steam pressure.

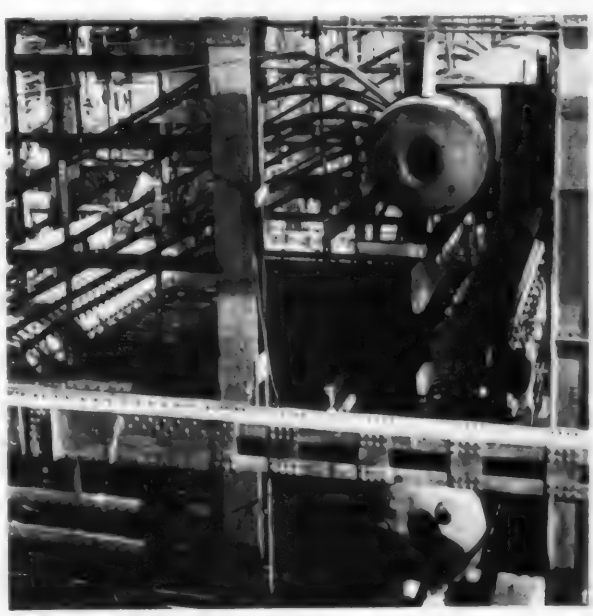


View of mechanical stokers being fed with coal from weighing machines. Note the instrument board for controlling the boilers.

Above.

Below.

Interior of modern water-tube boiler under construction.



Graphic Records

In addition to the points mentioned, engineers can get an unequalled insight into the operation of the boiler plant by studying the graphic records of individual boiler operation. The CO_2 recorder is invaluable (it is fitted to each boiler, as well as is a large-scale CO_2 indicator), for, upon comparing the CO_2 records with the steaming rates recorded by the steam-flow meter simultaneously, the rate of steam generation at which highest efficiency is obtained can be definitely known and maintained within practical limits. The value of the CO_2 recorder in this matter can well be understood with a little consideration of the principles of combustion.

Combustion of Coal

One of the chief factors in the combustion of coal is proper air supply. Air is composed of two gases, oxygen and nitrogen, in the proportion by volume of 21 per cent. of ozygen and 79 per cent. nitrogen, or by weight 23 per cent. oxygen and 77 per cent. nitrogen. The composition of pure dry air is by volume 20·91 parts O. and 79·09 parts N.; by weight, 23·15 parts O. and 76·85 parts N. The principal constituent of coal and most other fuels, whether solid, liquid, or gaseous, is carbon. Hydrogen is a light, combustible gas, and, combined either with carbon or with carbon and oxygen, in various proportions, is also a valuable constituent of fuels, notably of bituminous coal. The heating value of 1 lb. of pure carbon is rated at 14,500 heat units, whilst 1 lb. of hydrogen gas contains 62,000 heat units. Coal contains moisture, fixed carbon, volatile matter, ash and sulphur in various proportions according to its quality. The process of combustion consists of the union of the carbon and hydrogen of the fuel with the oxygen of the air. Each atom of carbon combines with two atoms of oxygen, and the energetic vibration set up by their combination is heat. Bituminous coal contains a large percentage of volatile matter which is released, and flashes into flame when the coal is thrown into the furnace, and it is necessary at this stage of combustion to supply a large amount of air, or much smoke will be formed and a considerable loss of carbon. Alternatively, admission of too much air will create loss because the excess air is heated to the temperature of the furnace without assisting combustion, and will discharge through the stack just as many heat units as were required to raise it from its original temperature on entering the furnace to that at which it enters the chimney. It is therefore obvious that considerable advantage will be gained by heating the air that is needed above the fire, and this is now being accomplished by installing air heaters after the superheaters and economisers have been served by the hot gases on their way to the stack.

High Furnace Temperature

It is essential if high efficiency is to be secured that a constant high furnace temperature be maintained and rapid combustion be secured, and these features can only be made available by supplying fresh coal all the time, at the rate it is being burned in the furnace, and also preventing the admission of *cold* air into the furnace.

For this reason mechanical stokers, well designed, are always fitted to modern boilers, as not only does a good travelling grate feed the coal just as quickly as is required, but it may be adjusted to a nicety by means of mechanism provided to govern the speed of the grate. At the same time the height of the fuel bed on the grate can readily be changed according to the particular requirements by raising and lowering the gate through which the coal passes from the bunker to the furnace. On the old-fashioned hand-firing plant more often than not the fireman throws in a heavy supply at each time of firing, with the result that the temperature of the furnace is greatly reduced, and this retards combustion. Also, with this type of furnace doors do not need to be opened, and this prevents a rush of cold air which would further reduce the furnace temperature. The combustion engineer knows that the source of the greatest loss of fuel, then, is an excessive supply of air, and as the CO_2 indicators and recorders show whether maximum furnace efficiency is being obtained, comparison of the records of the boiler performance as indicated and recorded by the steam-meters, with the CO_2 is regularly carried out. The temperature of the gases is also considered in relation to CO_2, as it plays a considerable part in deciding the losses. The following reliable figures will give solid reason for recording CO_2 and temperatures of gases:

Gas Temperatures where CO_2 Reading is Taken.	*CO_2 Percentage in Gas.*	*Heat Loss in Chimney Gases, per Cent. of Coal Fired.*
425° F.	16	10
,,	14	11·5
,,	12	12·5
,,	10	15·0
,,	8	19·0
,,	6	25·5
,,	4	38·0

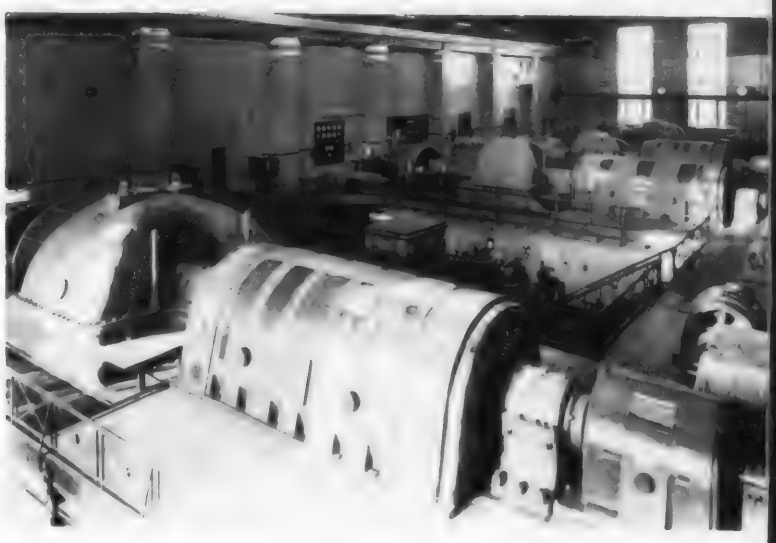
The higher the temperature for any given CO_2, the greater the loss than that shown above.

It is impossible in a short article of this kind to enumerate in detail all the refinements of modern boiler-house practice, and volumes would be required for that purpose. At the present time, however, it does seem to be necessary to investigate how far it would be wise to spend money in order to save fuel. Coal prices are rapidly rising, and will continue to do so, and there is no doubt whatever that factory power-stations would benefit by equipping them with sufficient measuring apparatus to enable the engineers to secure the information which would guide them to the cheapest form of plant operation for their own particular plant, as well as lowering the cost of production.

A MODERN POWER-HOUSE

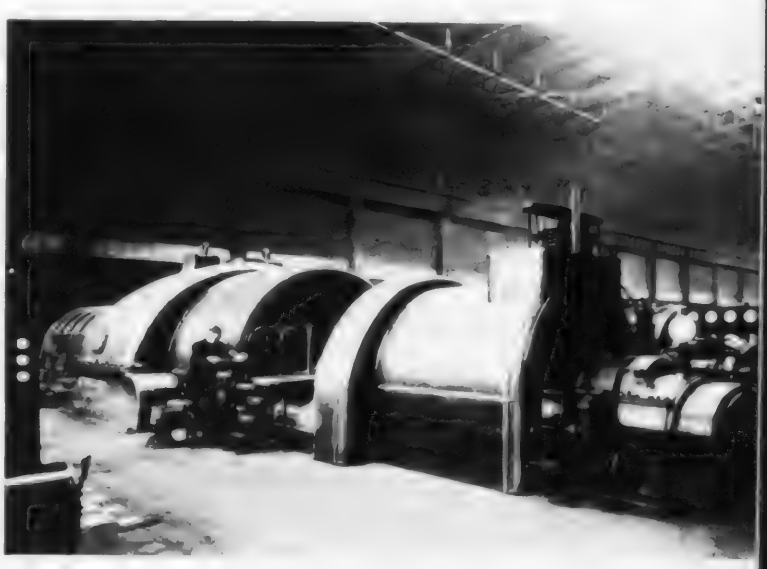
The following is a description of a typical power-house in which the principles outlined in the preceding remarks are fully adhered to.

The plant at this power-house has been so designed



Steam passes from the boilers to the turbo-alternators. A general view of the turbine room.

Steam leaving the turbines is passed on to the condensers. The illustration shows the condenser basement of a power house, with condensers, evaporators, feed heaters and pumps.



It is important that oil for bearings on high-speed turbines be kept clean. This shows an attendant operating an oil strainer on a large alternator set.

that the minimum of handling is required. It provides for delivery either to a storage dump or can be sent by means of conveyors to the bunkers immediately above the boilers, the conveyors being fed from hoppers. The coal, which is delivered by rail, is fed from the wagons by tipplers, in each of which is provided an automatic weighing device, these being in addition to the weighing machines installed between the bunkers and the boiler furnaces.

After the coal has been burned, the ash is discharged by the travelling grates into water troughs in the boiler-house basement, from which it is discharged into a sump, from which it is lifted by an elevator to a conveyor, which finally drops it in a bunker placed high enough for wagons to be run underneath it and readily filled by opening a gate at the bottom of the bunker.

Feed Water

The boiler is served with feed-water lines, which are duplicated so that at all times there will be water available even if "trouble" should occur on one line, and the arrangement of piping and valves permits the water to be diverted to serve any boiler as required. Before make-up water is added, it is treated in water-softening plant, and, in addition, all clean water drains are collected, and after passing through a cooler is sent to the condensers, where it is de-aerated, and eventually returns to the feed lines. Boiler-house instruments provided include indicators for CO_2, steam flow and draught for each boiler, the boards carrying these instruments in each case being placed close to the individual boilers they serve and easily seen by the firemen.

Central Control Room

A central control room for the boilers is installed, in which are CO_2 recorders; distance thermometers, electrically operated; steam flow recorders as well as integrating and summation watt-meters for the purpose of centralised control. The log-sheet included in this article is of interest. It will be noticed that provision is made for hourly readings to be taken and recorded, and sufficient data are thus collected to supply the station superintendent with test results at the end of each shift of eight hours. This is considered important, insomuch as any failure of the plant to work efficiently is noted quickly, and, where possible, immediately rectified. In order that good or bad operating may be traced to the people responsible during each day, the shift engineer commencing a shift personally reads the steam flow integration and the meter for the coal, in the company of the engineer he relieves and the figures are noted upon the log sheet. And so the check on heat units is carried on whenever possible, starting at the coal going to the bunkers; again, just before entering boiler furnaces, in the gases at various points in the flues. Observation is also kept and recorded of temperature of feed water entering and leaving the economisers, the steam leaving the superheaters, entering the turbines, at the condensers, and finally at the surge tank.

Supplying Electrical Energy

At this power-house are installed turbines of the two-cylinder impulse type capable of supplying, through the alternators to which they are coupled, an aggregate of 150,000 kilowatts of electrical energy. The turbines are supplied with steam at a pressure of 300 lb. per sq. in. gauge, which has been superheated to a final total temperature of 700° F.

In the high-pressure cylinder are contained twenty expansion stages for the steam, while in the low-pressure cylinder the steam, having been expanded through two stages, is led off in two streams, one of which goes to the second half of the cylinder to pass through three expansion stages to the condenser, and the other stream is expanded through one ordinary and one multi-exhaust stage to the common exhaust. The coupling between the high-pres-

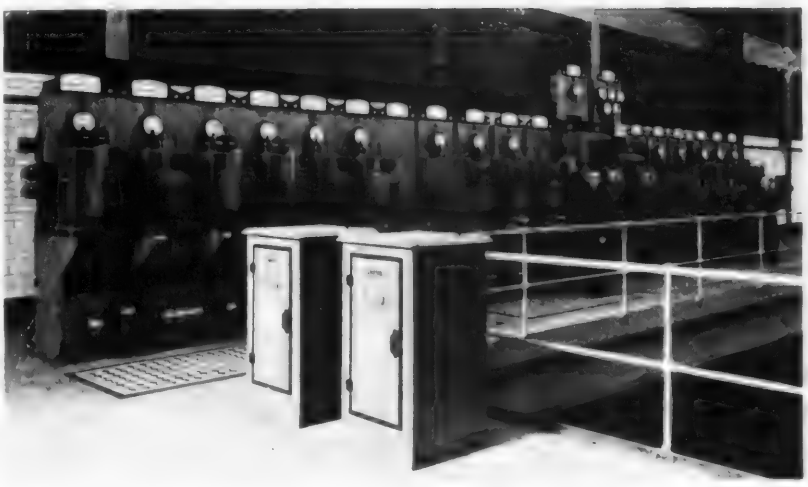
RÉSUMÉ OF VARIOUS COAL TRIALS

(Made on Arrival and/or Afterwards)

Calorific value (B.T.U.)	14,170	14,480	15,210	15,435	14,310
Coal consumed (lb.)	1,730,030	150,614	5,688,050	362,002	5,179,313
Water evaporated (lb.)	14,994,593	1,468,474	56,777,160	3,755,120	55,964,587
Ashes produced	Not given	Not given	46,150	32,208	46,772
Percentage of coal as burned	,,	,,	10·0	8·0	11·4
Average steam pressure	112	110	113	114	115
Average corresponding temperature	345·1	343·0	345·7	340·3	340·0
Average superheated temperature	451·0	450·0	480·0	480·0	480·0
Average added temperature	106·0	106·0	135·0	133·7	133·0
Average temperature gases entering economisers	650·0	720·0	700·0	750·0	650·0
Average temperature gases leaving economisers	350·0	375·0	300·0	380·0	320·0
Average temperature water entering economisers	140·0	165·0	100·0	100·0	150·0
Average temperature water leaving economisers	240·0	280·0	300·0	295·0	265·0
Average rate of evaporation per lb. coal	8·6	9·2	9·9	10·33	10·8
Average rate of evaporation from and at 212	10·10	10·64	11·57	12·07	12·45
Average factor of evaporation superheat included	1·1170	1·1568	1·160	1·168	1·181

APPROXIMATE EFFICIENCIES

Overall percentage	69·0	71·3	73·81	79·15	84·42
Of boilers only	57·0	57·5	60·21	65·05	71·22
Of economisers	12·0	13·8	13·60	13·50	13·20
Saving due to economisers	9·0	10·36	12·7	12·60	10·45
Price of coal (per ton in England)	£1 9s. 4d.	£1 7s. 4½d.	£1 8s. 3d.	£1 9s. 0d.	£1 9s. 3d.
Total cost of generating 25,000 tons steam (month)	3630·6	3216·0	3056·6	3009·1	2936·14



Operating an auxiliary control board supplied with current from the turbo-alternators.

sure and low-pressure turbines is of the flexible type, and the alternator is connected to the low-pressure turbine by a semi-flexible coupling.

The Condensers

The condensers through which the steam flows after discharge from the turbine are of the central-flow type, in which the air is withdrawn from a group of tubes, and the steam is admitted around the greater part of the periphery, which reduces the drop of pressure between the steam inlet and the suction of the air pump, producing a corresponding increase in the rate of transfer of heat from the exhaust steam to the circulating water.

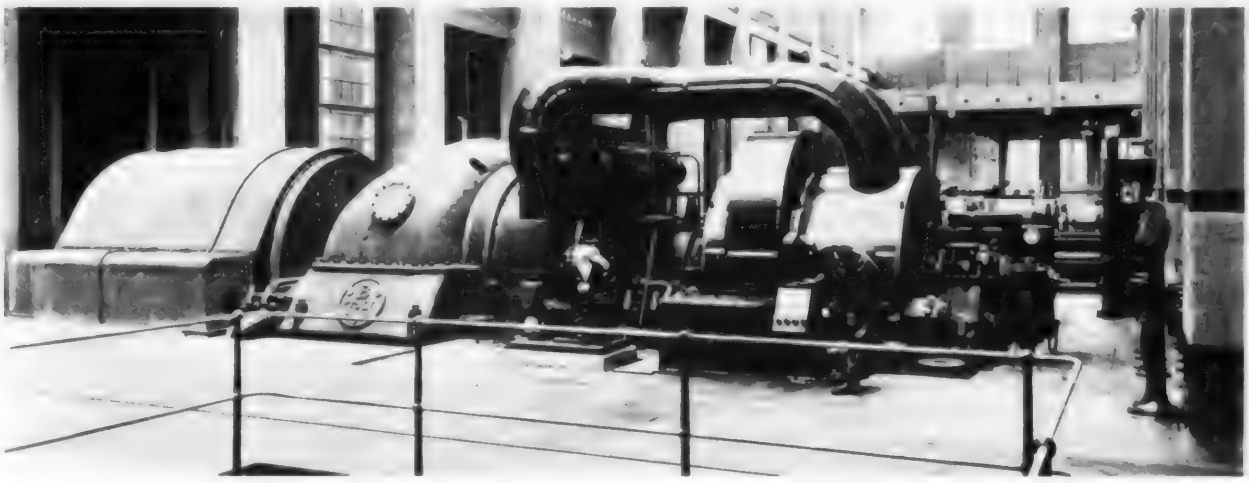
The water box of the condenser is in two sections, permitting only one-half of the condenser to be in operation, while the other is out of commission if required. Extraction pumps withdraw the condensate from the condenser which, after passing through two main and two auxiliary feed heaters, is delivered to the feed pumps.

Auxiliary Heaters

While steam for the main feed heaters is supplied from two low-pressure stages in the turbine, the auxiliary heaters are given exhaust steam from steam-operated air ejectors and leakage steam from the high-pressure turbine gland respectively, with the result that the temperature of the condensate is raised from 80° F. to 200° F. approximately. Any fluctuations in feed-water supply are prevented by a surge tank, which maintains a constant head, and the whole system works on a closed circuit.

Step-up Transformers

Each alternator is connected to step-up transformers, and the current after passing through metal-clad compound-filled switches is led to the bus-bars. Synchronising and circuit switching is all done from a control room which is isolated from the rest of the power house. Attached are reports of five actual tests in a boiler-house taken over five successive months. During the whole of the period careful notice was taken of the various pressures and temperatures as shown on the left, and it will be noted that the overall percentage of the boiler-house plant increased from 69 per cent. to 84·42 per cent., while the total cost of generating 25,000 tons of steam decreased from £3,630 6s. to £2,936 14s.



One of the latest developments in turbo-alternators. An extraction type turbo-alternator installed in a large industrial undertaking with steam at 1,200 lbs. pressure and 900° total temperature.

STEAM TRAP CAPACITY

What determines the capacity of a steam trap? R. E. ASHTON, while not advocating the selection of traps on a capacity basis regardless of other considerations, considers it more important than inlet and outlet diameters.

IT is peculiar that, in an age when engineering has progressed at an unprecedented rate, one occasionally comes across odd fragments from bygone days left high and dry.

Improvements in Design

After a period of stagnation, the design of steam traps, in common with many other mechanical devices, has surged forward. The upright bucket has been largely displaced by the inverted bucket and the capsule by the bellows. The importance of entrained air and incondensable gases has been appreciated by manufacturers. Size and bulk are no longer criterions of efficiency and reliability. The erstwhile competition between float and thermostatic types has been clarified by a general realisation that both have their legitimate sphere, which do not overlap to any extent.

It is all the more strange, then, to observe that the old and erroneous practice of thinking of traps in terms of inlet and outlet size persists to an amazing degree. One does not choose a boiler by size of outlet, but by evaporative capacity; nor does one order a motor by shaft diameter, but by horse-power or "power capacity". Given sufficient metal, one can drill and tap a trap body to take any size of pipe, but the essential characteristic of the trap—viz., the quantity of condensate which it will pass under specified conditions—will not be affected to any extent. Bearing in mind that traps which are undersized in capacity are a liability against production, and oversized traps an unnecessary expense, the question of the correct sizing of steam traps appears to be a matter worth a little consideration.

Capacity of Traps

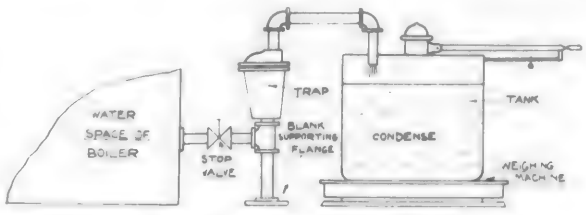
What determines the capacity of a trap? Obviously no trap can pass more condensate than will flow through an orifice the area of which is equal to that of the valve seat fitted.

Whether the trap is float, bucket, or thermostatic, this area is determined by the maximum pulling power which the operating element can develop in relation to the total pressure exerted on the closed valve by the steam in the trap at the moment of operation. If, therefore, trap A is claimed to have capacity substantially higher than trap B, which is fitted with the same size valve seat, it is apparent that there must be some restrictive element in B which does not exist in A, or that A is rated on a different basis from B. In all traps having the same size seat and being of modern design and sound construction it will usually be found that approximately similar capacities will be obtained under identical working conditions. Tortuous passages through which the steam or condensate is required to pass have a definite restrictive effect. This more particularly applies on the discharge side of the valve at medium and high pressure, for the following reason: assuming the trap to be efficient in so far as it discharges all condensate as formed, such condensate will pass through the valve at a temperature above 212° F., with the result that a small percentage will flash into vapour until sufficient latent heat has been absorbed to reduce the sensible heat to 212° F. The vapour, sometimes called "flash-back" steam, and frequently mistaken for live steam, will set up a back pressure if formed in a confined space. As the rate of flow through the valve is governed by the pressure difference over the valve, this back pressure will limit the capacity.

Other Restrictive Influences

Other restrictive influences include partial valve lift and gradual opening and closing of valve as against sharp, decisive action. The insertion of strainers and check valves, though desirable and beneficial, is nevertheless restrictive to capacity, and where fitted as integral to the trap will have an adverse effect on the capacity characteristics of the traps.

Having decided to select traps on a capacity basis, the works engineer is confronted by a mass of contradictory and incomplete data published by the various manufacturers, consequent upon each manufacturer adopting an individual basis. "Cold-water capacities"—that is, capacities based on tests or calculations to arrive at the quantity of water at or below 212° F. which will pass through the trap at a given pressure—are no true index to

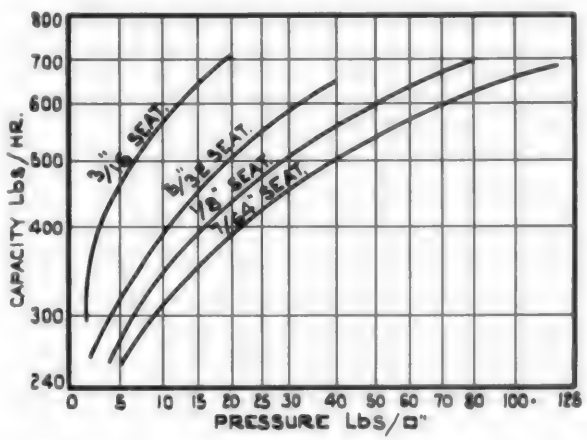


Showing a well-laid-out trapping installation. The clean sweep into the trap and the direct lift should be noted.

the capacity of the trap when discharging condensate, due to the formation of flash-back steam at the point of discharge and the back pressure set up on the discharge side of the valve. A series of tests recently carried out on one particular type and size of trap showed a loss of one-quarter to one-third capacity. Unfortunately, this cannot be taken as a constant for converting "cold" to "hot" capacities, as it was also discovered that the ratio varied according to the diameter of the seat and also according to the pressure. Further, the back pressure set up will vary, not only according to the design of the trap outlet, but also according to the bore, length, and run of the discharge pipe.

Tests with Sample Trap

Where it is possible to secure a sample trap for test, the question is easily resolved by connecting the inlet of the trap to the water space of a boiler and measuring the full bore discharge by weight over 60 seconds. Several tests require to be made on each trap, the results being averaged unless a wide deviation is obtained on any one test. Such a deviation would indicate a failure to duplicate the conditions exactly, and a little reflection will usually discover the cause. The figure obtained is the continuous discharge capacity of the trap, and constitutes a reliable yard-stick for comparative purposes. In order to obtain a working capacity figure, several various factors require to be taken into consideration, including the quantity of air and incondensable gases to be handled, loss of pressure at the inlet to the trap due to heavy load on the drained apparatus, lift, and back pressure due to steam leak from older traps on the same return main. For normal heating coil purposes a safety factor of at least 2 : 1 should be allowed. Many applications call for higher factors—as, for instance, the draining of quick-boil jacketed pans, where factors as high as 10 : 1 are not too much to allow under extreme conditions.



Showing four capacity curves obtained by fitting different sizes of valves in the ½-inch trap. Curves represent actual full bore discharge of water at steam temperature.

Acknowledgments to The Drayton Regulator and Instrument Co., Ltd.

Thermostatic Traps

The foregoing remarks apply more particularly to float- and bucket-type traps. Capacities of thermostatic traps require separate consideration, and are not at all so clear-cut, owing to the introduction of the valve-lift element. Obviously, as the operation relies upon temperature differences, the condensate cannot be discharged until it has cooled below the steam temperature. For instance, if tested on the water space of a boiler, the trap would not open to discharge at all until heat loss by radiation from the trap and connecting pipe had accounted for the required temperature drop. The longer the connecting pipe and the lower the ambient temperature, the greater would be the discharge obtained until the drop required to give full opening of the valve had been obtained. In applying any continuous discharge figure obtained to working conditions, allowance must be made for the nature of the application. For instance, condensate from gilled heating pipes or radiators used for room heating would normally have cooled to such a degree by the time it reached the trap that a full-bore discharge would be obtained. On the other hand, condensate from a unit heater or other apparatus where condensation is forced arrives at the trap at a temperature approximating to the steam temperature, and the discharge capacity of the thermostatic trap will be limited accordingly unless installed at a sufficient distance from the heater to permit the necessary temperature drop by radiation.

Float and Bucket Traps

Reverting to float and bucket traps, a preliminary comparison of valve diameters will enable the possible to be seeded out from the impossible and reduce testing to reasonable proportions. To avoid misunderstanding, it should be made clear that the writer does not advocate selection of traps on a capacity basis regardless of other considerations. Steam traps are a capital expenditure and may be an expensive investment unless careful consideration is given to wearing qualities. The economy obtained by installing traps selected solely on a capacity/price basis may quickly evaporate in steam loss consequent upon rapid deterioration of working parts, not to speak of frequent maintenance charges, cost of spare parts, and lost production. These matters are not within the scope of the present article, which is concerned solely with directing attention to the desirability of selecting traps on a capacity basis rather than by inlet and outlet diameters.

INDEX

To "Food Manufacture"

Copies of the comprehensive 6 page index to last year's issues are still available to subscribers, who should apply to:

The Publishers, *Food Manufacture*
17, Stratford Place, London, W.1

THE ADJUSTMENT OF REACTION OF TERMINAL RESIDUES OF BAKING POWDERS

SIMON MENDELSOHN,
F.A.I.C.

ESSENTIALLY and regardless of type, all commercial baking powders consist of sodium bicarbonate in combination with one or more acid media, in admixture with starch. Definite formulæ have been developed by the various manufacturers to meet standards of quality imposed by preferential specifications, established trade practices, or expediency in the interests of economy. Such variations are, of course, permissible, providing that the finished commodity conforms with mandatory requirements.

Variations in Mixing

Correctly formulated baking powders, prepared with proper proportions of ingredients, frequently tend to leave mixers in a form not at all in accord with required tolerances. This may, in the absence of other causes, be attributed to adventitious variations in the mixing operation. Assuming correct quantities of raw materials of accepted purity and initial particle fineness to be assembled for compounding a baking powder, the next step consists of sifting the stock through mechanically operated screens. These are usually of box type, wherein two or more inclined sieve surfaces are superimposed within a rigid compartment, to which is imparted a rapid gyratory motion. All friable aggregates are reduced in size, and only material of consistently uniform granular fineness is consequently discharged into the mixing tanks; any portion of stock resisting the action of the sifters is automatically removed and discarded. The several ingredients having been passed through screens into the mixing compartments, the process from this point assumes formidable importance. This circumstance arises from the fact that complications may inevitably ensue in efforts to effect uniformity of composition through mixing of dissimilar pulverulent or granular solids. Mechanical mixing of bulk quantities of such dry materials in a more or less fine state of subdivision involves numerous factors, including, among others, the densities and particle size of the powders, as well as the duration and speed of agitation. Each mixing appliance, even though constructed as an exact duplicate of another, is characterised by a different and individual efficiency factor based on time required to yield a perfect mixture. Size of batch and number of ingredients are further variables that exert significant influence upon the degree of physical homogeneity of a powdered mixture.

Burton,[1] in an interesting exposition of this subject, cited investigations of Catlin[2] as to the possibilities of inducing alternate states of physical heterogeneity through excessive mixing of materials comprising a baking powder. The efficiency of any mixing involving powdered materials does not proceed uniformly to a definite state of completion, but is subject to variations that can be plotted by a series of symmetrical undulations denoting mixing, and partial unmixing or segregation. These phases are indicated in the accompanying graph, based on data obtained in the course of mixing a 5,000-lb. batch of baking powder.[1, 2]

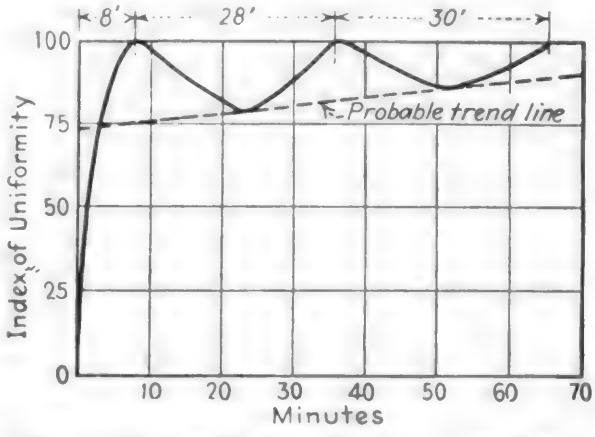


Chart showing progress of mixing. It is important to stop machine when the index of uniformity has attained its maximum. This phenomenon of alternate mixing and segregation (partial unmixing) varies with every mixer and mixture, and is observable only when blending dissimilar granular substances.

Courtesy of "Food Industries", N.Y.

It is apparent in the above instance stressed by Burton that 28 minutes of machine operation would prove totally unproductive if mixing were prolonged beyond the initial peak. That writer defined Index of Uniformity (see coordinates of graph) as an arbitrary indication of the physical condition of a powdered mixture, on a scale ranging from 100 to 0; these extreme points denote degrees of uniformity varying respectively from a state of perfect mixing to visibility of only one ingredient in an observed microscopical field. An index of 50 would accordingly represent a condition resulting from very inefficient mixing, while even 85 would indicate an average deviation of 15 per cent. from an ideal mixture. As a microscopical procedure the technique is based upon enumeration of the various particles constituting a tentative sample of a mixture.

Numerical comparisons of the mean ratios of such particles with those of a particular constituent are referred to standard ratios representing known proportions of the

various ingredients in a specified formula. The original paper[1] should be consulted for further manipulative and interpretative details, particularly for the application of the method to mixtures of several components, calculation of average deviation, and percentage index of uniformity.

Other Causes of Imperfect Blending

Aside from any adverse results that may occur through improper mixing, there still remain the most common causes of imperfectly blended baking powders. Pronounced strength variations of certain of the raw materials, or gross errors in weighing and compounding, are capable of promoting detrimental effects upon the efficiency and keeping quality of the finished commodity. All things being equal, the most serious result of maladmixture lies in the impaired gas content and the unintentionally acquired reaction of terminal residues upon decomposition of the powder with water. Ordinarily, leavening mixtures are formulated in such manner that their residua are neutral or else characterised by an alkaline reaction resulting from 1 to 3 per cent. surplus soda in the batch. Apart from difficulties that may arise from the mixing operation alone, an acid residue would indicate an excess of baking acid or a corresponding deficiency of soda. Surplus acidity is conducive to premature deterioration of a leavening mixture, in contrast with the improvement of keeping quality assured by a slight excess of alkalinity. Such excess of soda will naturally augment the total CO_2 content of the mixture, without increasing the percentage of available leavening gas incident to decomposition of the powder in the course of its use in baking.

A preponderantly alkaline reaction residue exceeding the value to include the intentional excess would, conversely, denote a surplus of soda or a singular insufficiency of the required acid constituent.

Laboratory Tests

With appropriate laboratory facilities provided for immediate production control, such gross errors in compounding or mixing can be readily detected and rectified prior to release of batches from the mixers. Determination of total CO_2 would afford some information in the instance of maladmixtures, but any fluctuations in the gas value might, on the other hand, be due to appreciable variations in the starch content of the powder. An excess of the amylaceous filler, variously designated as a dispersing agent or stabiliser, in baking powders would induce repression of the CO_2 content; a deficiency would tend in the opposite direction—namely, to increase the gas yield above the percentage desired.

Several control methods for the estimation of proper reaction values of leavening mixtures have been suggested from time to time, but in the main these have amounted to but little more than minor technique lying within the common ability of the layman to perform as occasion demanded.[3] A definite analytical procedure was utilised by Bryan, of Chicago, many years ago, and was eventually publicised by Luckow in 1926,[4] for the specific control of the residues of the combination type of baking powders. The procedure in modified form is readily applicable to all types of leavening mixtures while in process, or as a check on competitive brands of the product, but necessitates constant uniformity of technique and environment. The following analytical procedure yields a quantitative expression to the reaction of terminal residues, and is generally designated as the "neutral value" for baking powders.

Analytical Procedure

Place 1 gm. of sample into a 200-c.c. porcelain casserole, add sufficient hot water to take up the powder, introduce 8 drops of 0·5 per cent. alcoholic phenolphthalein solution, and heat the mixture to boiling. Stir continuously with a glass rod, occasionally rinsing the sides of the dish with hot water to return the frothy matter into the hot liquid. Maintain at boiling temperature until the CO_2 is completely removed, as indicated by cessation of effervescence. With powders predominantly alkaline, the liquid assumes a pink colouration of a shade depending upon the concentration of free (residual) alkali present. If the test fails to assume a pink colour at this point, the baking powder is predominantly acid. An excess of decinormal NaOH is then added, and the residual thereof determined by titration. The result is then calculated directly in terms of the surplus baking acid known to be present.

Note.—The boiling process completes the reaction between the acid media and soda. Any excess of the latter originally present is now converted to the normal carbonate according to the following transformation:

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O.$$

Assuming that the test material had assumed and retained its pink to red response to phenolphthalein, then introduce from 4 to 10 c.c. of decinormal H_2SO_4 in 2-c.c. portions, followed by boiling for 2 minutes until pink colour does not recur. In this manner the alkaline range of a powder can be ascertained. Immediately add a volume of decinormal NaOH corresponding to the quantity of standard acid originally used, and boil for 2 minutes. Test mixture may then be cooled and titrated with standard H_2SO_4, to the permanent disappearance of the pink colour. The result may be expressed arbitrarily in terms of c.c. of standard acid so required, or directly as soda by the use of the factor 0·8, derived as subsequently to be described. Excess alkalinity can be calculated on the basis of soda originally used in compounding a baking powder. In the reaction

$$2\ NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O.$$

involving only the surplus soda, the quantity of the latter can be determined from the results of above titration, on the following principle:

$$1\ \text{c.c. N/10 } H_2SO_4 = 0{\cdot}0053\ \text{gm. } Na_2CO_3,$$

therefore percentage of excess soda = c.c. N/10 acid × 0·0053 × 1·585 × 100 = c.c. acid × 0·84, on the basis of a 1-gm. sample.

Note.—The factor 1·585 represents the ratio $2NaHCO_3$ Na_2CO_3, or 168 : 106 respectively, wherein it is apparent

from the reaction that each part of Na_2CO_3 corresponds to two parts of $NaHCO_3$. This, of course, is based on the assumption that the reaction proceeds to completion.

Assuming a greater volume of decinormal acid to have been required than of alkali in the final titration, then, in the case of a combination baking powder, per cent. excess soda = (c.c. N/10 acid – c.c. N/10 base) × 0·0084 × 100 = c.c. acid × 0·84. Conversely, when more of the standard NaOH than of acid is required, then (c.c. N/10 base – c.c. N/10 acid) × 0·0081 × 100, or c.c. NaOH × 0·81 = percentage excess acidity, in terms of sodium aluminium sulphate when this is the predominant acid present. The factor 0·0084 is the equivalent of 1 c.c. of decinormal acid in terms of soda. The value 0·8 can be used in both of the above equations for excess of either acid or alkali. The factor 0·0081, as the equivalent per c.c. of N/10 NaOH in terms of acidity, is derived from the following equation for reaction between sodium aluminium sulphate and soda:

$$\underset{(484)}{Na_2SO_4.Al_2(SO_4)_3} + 6\ \underset{(504)}{NaHCO_3} \rightarrow 2\ Al(OH)_3 + 4\ Na_2SO_4 + 6\ CO_2.$$

It is therefore evident that 1 gm. molecular weight of soda corresponds to 484/6, or approximately 81 gm. of S.A.S. It thus follows that each c.c. of a N/1 solution of $NaHCO_3$ would be equivalent to 0·081 gm. S.A.S., or that 1 c.c. of a decinormal alkali would represent 0·0081 gm.

Excessive Acidity

Excessive acidity of a combination powder can ordinarily be safely attributed to S.A.S., since acid phosphate, usually present in proportionately smaller amounts, is immediately neutralised by the soda in the mixture upon the addition of hot water at commencement of the test. In view of the fact that the values per c.c. of final titration reagents are 0·0084 and 0·0081 for soda and S.A.S. respectively, it is expedient to use the common factor 0·008 in either case. This is fully warranted by the fact that in actual production on a tonnage basis such small differences may be ignored, except where gross errors in compounding are encountered. Adjustment of the reaction of baking-powder residues can be effected on the basis of data available through the above test. Each 1 per cent. excess soda in a batch, for example, is equivalent to 20 lb. per ton of powder. Neutralisation of this alkaline surplus can be accomplished by the addition of about the same weight of S.A.S., or, more precisely, 19·2 lb. According to the reaction between these ingredients as shown above, it is evident that the ratio of acid to alkali is as 1 : 0·96. Therefore 20 lb. excess soda per ton would require 20 × 0·96, or 19·2 lb. of S.A.S. for each 1 per cent. of surplus alkali in the batch. Conversely, with a baking powder containing 1 per cent excess S.A.S., or 20 lb. per ton, the reciprocal relationship between the acid and alkali is utilised, in accord, likewise, with the above leavening reaction. Neutralisation is, therefore, to be effected by the addition of an almost similar weight of soda, or, more accurately, 20 × 1·04, or 21 lb. to the batch during process of mixing. In the latter instance the factor is derived from the relationship $NaHCO_3$/S.A.S.—*i.e.*, 504/484, or 1·04. Adjustment of terminal reactions of other types of leavening mixtures are to be conducted along similar principles.

Phosphate Baking Powders

On the basis of the reaction

$$3\ \underset{(756)}{CaH_4(PO_4)_2.H_2O} + 8\ \underset{(672)}{NaHCO_3} \rightarrow Ca_3(PO_4)_2 + 4Na_2HPO_4 + 8\ CO_2 + 11\ H_2O$$

it is evident that each part of phosphate requires 672/756, or 0·888 parts of soda. Each 1 per cent., or 20 lb., of excess soda per ton, therefore, requires 18 lb. of the baking acid, or, more exactly (20 × 0·888), or 17·7 lb. With 1 per cent., or 20 lb., excess phosphate per ton, the reciprocal proportion as between soda and phosphate is used—*i.e.*, 756/672 respectively. Therefore a weight of soda equal to 20 × 1·125, or 22·5 lb., will be required for complete neutralisation.

Cream of Tartar Baking Powders

In accordance with the reaction

$$\underset{(188)}{KHC_4H_4O_6} + \underset{(84)}{NaHCO_3} \rightarrow KNaC_4H_4O_6 + CO_2 + H_2O,$$

each part of soda requires 188/84, or 2·24 parts of acid tartrate. Each 1 per cent., or 20 lb., excess soda per ton of mix will necessitate 45 lb. of cream of tartar, or, more precisely, 20 × 2·24, or 44·8 lb. On the reciprocal basis each 1 per cent. of this acid medium, or 20 lb. excess per ton, will require the addition of 20 × 0·45, or 9 lb. of soda.

Note.—With both cream of tartar and tartaric acid in a baking powder the residual acidity can safely be attributed to the bitartrate, since any free tartaric acid present exists in such minor quantities as to be neutralised immediately by the soda upon addition of water in conducting the test.

It is important to note that these calculations have all been based on an assumed 1 per cent., or 20 lb. per ton, excess or deficit of the several ingredients mentioned. For fractions or multiples of this quantity the computations for adjustment must be modified accordingly. Accuracy of the corrected batches is invariably to be confirmed by repetition of the titration test prior to release of a batch from the mixer. It is preferable to allow a slight predominance of soda in a formulation to assure the keeping quality of baking powders over reasonable periods of storage.

REFERENCES

[1] *Food Industries* (N.Y.), October, 1933, p. 391.
[2] Conducted in plant of the Rumford Chemical Works, Providence, R.I., and reported by Burton, *loc. cit.*; *cf.* also Mendelsohn, S., *Chemical Industries* (N.Y.), June, 1938, pp. 630-33, on the Industrial Aspects of Baking Powder.
[3] Fiene, F., and Blumenthal, S., *Handbook of Food Manufacture* (N.Y.), 1938; Hart, R. N., *Leavening Agents* (Easton), 1914; Foot, F. N., *Baking Powder and Other Leavening Agents* (N.Y.), 1906, and subsequent edition.
[4] Transcript of Record, Federal Trade Commission *vs.* Calumet Baking Powder Co. (Chicago), Docket No. 1127 (1926): Official Report of Proceedings, p. 3169.

BIBLIOGRAPHY

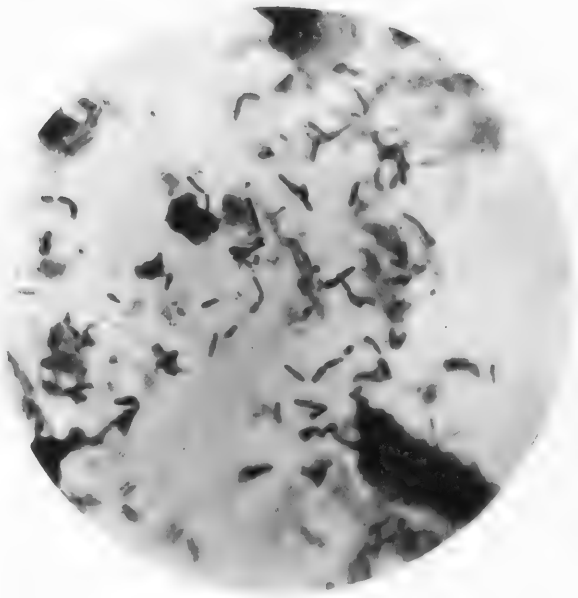
Mendelsohn, S.: "Combination Baking Powders," Food Manufacture, September, 1939, pp. 313-16.
Mendelsohn, S., *Baking Powders* (N.Y.), 1939.

FOOD POISONING

Part VII

BOTULISM

ELLIOT B. DEWBERRY
M.R.I.P.H., M.R.San.I.



Cl. Botulinum Type A.

BOTULISM has been systematically studied by numerous scientific investigators in the United States of America, and many brilliant contributions have been added to the literature on the subject by Bengston, Dack, Damon, Dickson, Dubovsky, Geiger, Jordan, Meyer, Ophüls, Tanner, Thom, Wilber and others.

The disease apparently increased in the United States during the period 1910-1922, but later showed a distinct tendency to decrease. Meyer is of opinion that the decline in the number of outbreaks or single cases is attributable to energetic preventive measures, both educational and legal. From 1899 to 1925, 146 outbreaks of botulism, affecting 504 persons, were reported in the U.S.A. and Canada, with 337 deaths.

During the Great War (1914-1918) apparently no cases of the disease were recorded amongst the British or Allied troops, although the consumption of canned and preserved foods was enormous. This was doubtless due to rigorous inspection and supervision of supplies and to increased efficiency in the canning industry.

Dorendorf, however, recorded 5 cases of the disease as occurring in the German Army, and Bitter observed 3 outbreaks at Kiel in 1918-1919.

In 1918 Dickson, as a result of his intensive investigations in America, compiled a clinical and experimental study on botulism. (Monograph No. 8 of Rockefeller Institute for Medical Research, N.Y.) He arrived at the conclusion that the disease was endemic in the United States and common on the Pacific coast.

In 1919 several spectacular outbreaks were caused by the consumption of factory-preserved olives, and for the first time the canning industry was confronted with the fact that *B. botulinus* was a real instead of merely a potential danger.

Impressed by the grave responsibility thrust upon the canning industry, the National Canners' Association, the Canners' League of California and the California Olive Association proposed an investigation to determine the danger of botulism—how it arose and how it could be avoided and overcome. A Commission was formed in California (Geiger, Dickson and Meyer), and as a result of their researches "The Epidemiology of Botulism" (P.H. Bulletin No. 127) was published in 1922 by direction of the Surgeon-General.

Since 1929 the entire preserved foods industry of California has been controlled through legislation by the California State Department of Public Health, and revised tentative regulations covering sterilisation of products are issued during the packing season of the year for the guidance of the industry.

Among the principal works in the United States of America containing matter relating to botulism are those by Dickson (1918), Demon (1928), Jordan (1919-1930), Meyer (1928), Bengston (1924), Tanner (1923). In addition, and as a result of experimental work and study of the disease by various scientific workers, a number of pamphlets have been published, and numerous articles have appeared from time to time in scientific and medical journals.

The prevalence of botulism in Russia was reported in 1927 by Zlatogoroff and Soloviev. Twelve outbreaks occurred between 1881 and 1926 with 52 cases and 35 deaths. The disease appears to be spreading more and more in the republic.

Botulism in Great Britain

No authentic cases of botulism were recorded in Great Britain until August, 1922, when an outbreak occurred

Cl. Botulinum Type B.

at Loch Maree, Gairloch, in the Western Highlands of Scotland. Eight persons were affected, and all died within a week after eating sandwiches made with duck paste. The outbreak formed the subject of a special report (1923) by Gerald Leighton to the Scottish Board of Health.

In 1923 Leighton published his work on "Botulism and Food Preservation", in which he gave a comprehensive study of the Loch Maree outbreak. This publication marked an epoch in the medical literature in this country, as it was the first British work on the subject.

In the same year an up-to-date review on the disease was included in the *Medical Science Extracts and Reviews*, Vol. 7, by the Medical Research Council (Humphrey Milford). In 1929 the Medical Research Council published "A System of Bacteriology in Relation to Medicine" and in Vol. 3 *Cl. botulinum* was dealt with by Hewlett, O'Brien and Bullock.

Since the Lock Maree outbreak in 1922, there were no authenticated cases until August, 1935, when 3 deaths definitely due to botulism occurred in North London. The Chief Medical Officer, Ministry of Health, in his Annual Report for 1935, remarks: "These fatal cases were all adult women, and there were two others, both male, in which the same intoxication was almost certainly a contributory cause of death. . . . One man, who had partaken of the dish responsible for two of the fatal cases, recovered after presenting slight symptoms of botulism and being treated with botulinus anti-toxin".

Later in August, 1935, another fatal case (a man) occurred in London, in which the symptoms suggested botulism. The findings at the post-mortem examination were consistent with death from botulism. The above outbreaks will be dealt with in detail.

Botulism is an example of food poisoning due to bacterial products formed outside the human body. It is an intoxication and not an infection. In other words, for human botulism to result, the causative organism must multiply and produce its toxin in the food before it is consumed.

B. botulinum (now designated *Clostridium botulinum*), which was described by Van Ermengem in 1895-1896, is an anaerobic bacillus 3 to 8 microns in length (a micron = 0·00039 of an inch) with slightly rounded ends. It is sometimes seen in spindle-form and often arranged in pairs or short threads. The bacillus has 4 to 8 flagellæ of wavy form which enable it to move in suitable surroundings. Oval spores are formed, seen as swellings at or near the end of the organism. These spores are very resistant to heat, and may in favourable circumstances remain dormant for quite long periods before germinating.

The bacillus, which does not grow in a medium which is at all acid, if cultivated in a suitable medium under anaerobic conditions at a temperature of 20° to 35° C., produces a powerful toxin which permeates the medium, at the same time emitting a rancid odour. The toxin, when fed or injected into susceptible animals, causes the characteristic symptoms of botulism.

There are several strains of *Cl. botulinum*, but the two main toxigenic types designated "A" and "B" cause botulism in man. A third type "C" is associated with a disease of chickens and ducks in America termed "Limberneck" (Bengston, 1922-1923). A fourth type "D" has been isolated from cattle in South Africa, and a fifth "E" from a disease in horses, also in South Africa (Theiler and Robinson, 1928).

All the above strains are anaerobes. Types "A" and "B" can grow in approximately 7·5 per cent. of normal atmospheric oxygen, but type "C" only when the amount is less than 3 per cent. of the atmospheric oxygen.

Occurrence of *Cl. Botulinum* in Nature

According to the available evidence *Cl. botulinum* is found all over the world, its natural habitat being the surface layers of virgin soil. It is, however, present to some extent in cultivated and other soils. The longer the soil has been in cultivation the less common is the organism.

It may gain access to vegetables, fruits, hay and other produce and be transported by insects.

For many years after the discovery of the bacillus by Van Ermengem, scientific observers endeavoured to isolate it from the intestines and fæces of pigs and other animals but without success.

Recent researches by Tanner and Dack, 1922, and Easton and Meyer, 1924, show that the bacillus is occasionally found in the fæces of certain animals which feed on soil produce, but it is not a normal intestinal inhabitant.

Dickson remarks: "There is no doubt that botulinus spores may persist for a time in the gastro-intestinal tracts of animals and man, although the majority of

recorded instances have been under experimental conditions or in human beings who have survived botulinus poisoning. In one human case which was in Stanford hospital the stools were positive 12 days after the food was eaten, and in a hog which had been ill after eating spoiled home-canned peas the fæces were still positive 3 months later."

In America extensive investigations into the occurrence and distribution of *Cl. botulinum* in nature were carried out by Meyer, Dubovsky, Geiger, Burke, Tanner, Dack and others.

Burke (1919) demonstrated that fruit, vegetables and animal food in California may be contaminated by the spores of the organism.

Meyer and Dubovsky (1922) examined a large number of samples of different soils from many parts of America, from England and also from numerous other countries. They found that types "A" (chiefly from virgin soils) and "B" (chiefly from cultivated soils) were widely but unevenly distributed.

They also examined vegetables and fodder from States in America and obtained positive results.

In 1928 Leighton and Buxton examined 100 soils from various localities in Scotland and isolated types "A" and "B".

Type "C" has been found by various observers in soils from chicken runs and stables where outbreaks of limberneck or botulism in horses have occurred. This particular strain was also isolated by Bengston from fly larvæ (*Lucilia cæsar*).

Foods Associated with Botulism

History relates that the incriminated foods in the earlier cases of so-called "sausage-poisoning" were of animal origin—*i.e.*, sausages and "made-up" foodstuffs containing liver, sheep plucks, tongues, veal, pork and blood. These were usually smoked or partially cooked.

It is an interesting and significant fact that in 1820 Kerner noted that when the sausage casings were incompletely filled they did not become toxic, and concluded that exclusion of air was necessary for the development of the poison which caused the characteristic symptoms of the illness. Kerner also observed that the poisonous meat food had a peculiar odour, differing from that of putrefaction; this he described as "cheese-like", the taste being sour and bitter.

Later, in the outbreaks of botulism in Central Europe, other foods of animal origin were implicated. These were in more or less spoiled condition, probably due to being only partly smoked, home pickled or insufficiently cooked. They included pickled and salted hams or fish, pork, preserved meats, game, potted goose or duck and brawn. It has been suggested that in the case of hams the contamination was introduced through the bone marrow. Toxic portions have often been found in the deeper parts of ham, which is favourable for the anaerobic growth of the spores of *Cl. botulinum*.

No cases of botulism appear to have followed the consumption of fresh food cooked or uncooked.

In America, although preserved meat products, fish, shellfish, cheese, etc., were among those foods formerly associated with cases of botulism, in recent years the majority of the outbreaks have been assigned to canned or bottled fruits and vegetables. These included spinach, peas, string beans, asparagus, olives, sweet corn, beets, onions, apricots and pears. The fruits and vegetables were mostly home preserved in cans or glass jars and were consumed cooked or uncooked or in the form of salads. String beans, it is recorded, accounted for 19 out of 55 outbreaks.

The wide distribution of *Cl. botulinum* in the soil of America seems to offer sufficient explanation of the contamination of so large a variety of foods. Jordan remarks: "Provided the food substance is not too acid or too alkaline and is shut up from all free access of air, almost any food seems able to serve as a culture medium for the specific bacillus".

British Outbreaks

The foods responsible for the cases of botulism which have occurred in Great Britain were as follows:

(1) Loch Maree, Scotland, 1922. Potted wild duck paste in glass containers.

(2) North London, 1935. Vegetable, nut, meat brawn in airtight glass jars. This consisted of a mixture of various vegetables (carrot, turnip, peas, beans, marrow, etc.) with ground-up nuts of different kinds, bread crumb, flour, herbs, spice and hard-boiled eggs embedded in an agar jelly flavoured with marmite.

(3) North London, 1935. Steak pie.

Physical Appearance

The early history of botulism records that the contaminated foods were spoiled or decomposed. In recent years, although this condition has not been observed in

Cl. Botulinum Type C.

every instance, in the majority of outbreaks the foods showed more or less marked changes from the normal or were noticeably spoiled. In the case of home-preserved fruits and vegetables in jars, bubbles of gas were present and the liquid squirted out when the tops were unscrewed. The contents had a disintegrated appearance, bitter taste and gave off a smell like rancid cheese or butter. When the food was preserved in cans these were sometimes blown and the contents had a mushy appearance and rancid odour. In occasional instances, however, the canned food presented no abnormality in consistence or odour although the toxin was present. In other cases the rancid smell was only noticeable when the food was heated, while the physical disintegration was slight. Cloudiness of the brine or liquor may be the only sign of bacterial activity.

Mortality

The mortality-rate for botulism varies considerably in individual outbreaks, and figures ranging from 20 to 70 per cent. have been recorded by different observers. In the Loch Maree outbreak in Scotland it reached 100 per cent.

American statistics show that from 1899 to 1928 a total of 529 cases of botulism with 357 deaths were recorded, giving a case mortality of approximately 67·5 per cent. In Germany the death-rate is considerably less and averages about 25 per cent. The fish-poisoning outbreaks of botulism in Russia have been accompanied by a high mortality amounting to about 67 per cent. The difference in the rate in America and Europe is probably attributable to the nature of the particular kinds of food consumed in the country concerned. The mortality-rate for children is higher than for adults.

It would appear that the earlier the symptoms of the disease the higher the mortality-rate. In America, Burke (1921) reported these death-rates: Among those showing symptoms in 24 hours, 84 per cent. died; of those that developed symptoms in 72 hours, 55 per cent. died; and of those alive after the eighth day, 20 per cent. died.

Meyer points out the interesting fact that isolated cases and deaths of botulism occur most frequently in women who, as cooks and housewives, are likely to taste foods of their own preparation, which, from odour or appearance, they suspect.

From the above figures it is obvious that the mortality-rate for botulism is very high as compared with other types of food infections.

Climatic Influence, Seasonal Prevalence and Intoxicating Rate

Botulism bears no relation to climate. As a rule the disease is associated with preserved foods, the consumption of which usually takes place in the winter months. According to Dickson, Geiger and Meyer more than half of all the outbreaks in California occurred during the autumn and winter months (October to February), in contrast with bacterial food infections, which are prevalent during the summer months.

The intoxication rate is very high, and as a rule all who consume the toxic food become ill.

The Toxin of *Cl. Botulinum*

The extremely poisonous substance produced during the growth of *Cl. botulinum* (strains A, B and C) in a suitable medium under anaerobic conditions and at a proper temperature is a powerful, filterable, bacterial exo-toxin possessing certain physical and chemical characteristics. It is the only one of the true toxins that is poisonous when taken by the mouth.

Meyer found that an incubation period of 10 days at a temperature of 35° to 37° C. furnishes a toxin of the highest potency. It may, however, develop in small quantities at temperatures below 20° C. and up to 34° C. Minute quantities of the toxin are fatal when injected into experimental animals, "the fatal dose for a guinea-pig of 250 grm. weight being in some instances 0·0005 c.c. of the filtered toxin" (Muir and Ritchie). The toxin is not formed in brine containing over 9 per cent. of sodium chloride.

Experiments by Church and by Geiger indicate that under laboratory conditions it is possible to poison animals with botulinus toxin through lacerations in the gums or abrasions in the skin. So great is the toxicity that minute quantities are sufficient to cause the death of small susceptible animals. In nature, however, it is probable that such a method of inoculation is of little importance; certainly it is true that there is no proved record of the poisoning of human beings except when the toxin is ingested.

Toxicity for Human Beings

As illustrating the highly poisonous nature of the toxin to human beings, Dickson (in America) records the case of a woman who died after nibbling a portion of a pod of spoiled string beans and of another who died from tasting a small spoonful of spoiled corn. Dickson remarks: "It is known that the sub-lingual mucosa permits fairly rapid absorption, and it is possible that the toxin may be absorbed in fatal quantities by this route".

The toxin, after ingestion, resists the gastric secretions and is absorbed by the stomach and small intestine without undergoing alterations.

The fatal dose for an adult man, calculated on the basis of animal experiments, might be as small as 1/100 mgm. or even less (Bengston, 1924). The various types of *Cl. botulinum* differ in the toxins they produce. Thus the antitoxin of toxin type "A" has no effect on toxin of type "B" and *vice versa*. The toxin maintains its virulence for 6 months or more if kept sealed in the dark. Putrefaction has no effect on its virulence if access of air is prevented.

Unlike the spores of *Cl. botulinum*, the toxin in solution is quickly destroyed by heat, but this varies according to the strain with which the food or medium is inoculated and the temperature of incubation. Exposure to 80° C. for 6 to 10 minutes is sufficient to render inactive the toxin produced by type "A". Type "B", however, requires 15 minutes' exposure to this temperature. The toxin of type "C" is more resistant and requires up to 30 minutes at 80° C. (Bengston) to destroy.

(*To be continued.*)

PAYMENT OF WAGES IN KIND

"BARRISTER-AT-LAW"

THE House of Lords have recently given a decision which is of considerable importance both to employers and employees. The case in question, Pratt *v.* Cook, Son and Co. (St. Paul's, Ltd.), concerns the effect of the Truck Acts on the manner in which wages are to be paid.

Employees Affected

The Act affects, among other persons, all artificers, handicraftsmen, and persons otherwise engaged in manual labour. And for this purpose, although the employee may have to exercise some degree of skill in the execution of his duties, yet if they are substantially of a manual kind he will be nevertheless regarded as being engaged in manual labour for the purpose of the Acts. Thus in the case in question a packer, whose duties required some skill, was nevertheless held entitled to the benefit of the Acts. But this is merely a minor point which was decided by the above case. The substantial point of the decision may, perhaps, be thus explained briefly.

Under the Truck Acts an employer must pay the wages of an employee wholly in current coin of the realm. No part of the same may be paid in kind at all. Likewise a contract between an employer and an employee whereby any part of the wages is to be paid otherwise than in current coin of the realm is absolutely illegal and void.

At the same time, however, the Act in certain circumstances authorises certain deductions being made from an employee's wages, but only if there is a written contract authorising the deduction, signed by the employee.

Apart from this essential condition as to the existence of a written and signed contract, a deduction may only be made from wages in respect of certain benefits enjoyed by the employee.

As far as is material here, deductions are only allowed in respect of medicine or medical attendance, fuel, rent of premises occupied by the employee, meals prepared on the employer's premises and consumed by the employee on the premises.

In Pratt's case it was this last-mentioned benefit which was enjoyed by the employee, and it is conceived that most employers in the trade who will be concerned as to the effect of the decision will be employers supplying their employees with meals on the premises.

It may, perhaps, be convenient now to illustrate the effect of the decision in Pratt's case. Suppose that the employee's wages are £3 per week, and that the cost of the meals supplied to him are 10s. per week.

What the employer may *not* do is to agree to pay the employee £2 10s. per week in cash and to give him free meals of the value of 10s. per week as well as part of his wages.

But, on the other hand, his employer may agree to pay the employee £3 in cash as wages and to deduct thereupon 10s. per week in respect of the meals to be supplied to him.

Whatever the form of the agreement, the ultimate effect is, of course, the same, for the employee would receive in either case £2 10s. in his pay envelope each week and be given his free meals of the value of 10s. each week.

But it is the form in which the transaction is carried out which is material. According to the one, the law would be broken, and the employee who had received his free meals would, notwithstanding, be entitled to recover from his employer a sum equivalent to 10s. per week for each week in which the illegal transaction continued.

While if the transaction took the other form—*i.e.*, that of a deduction from wages—and if there was a written agreement signed by the employee authorising the deduction, the employee would not be entitled to complain.

We propose to suggest a form which may be adopted by employers to legalise their position for the future; that is to say, in those cases where an employee is given, for example, meals on the employer's premises.

But before dealing with this matter we would draw attention to a further point. In some cases employers, in view of Pratt's case, have formally dismissed their employees and have re-engaged them on the terms that the latter are to waive any claims that they may have against the former in respect of deductions made in the past which may have been unlawful by reason of the Truck Acts and the decision in Pratt's case as to their effect. It is a moot point whether such agreements would be regarded as being effective for the purpose of freeing employers from liability for past breaches, but in any event employers can, at any rate, safeguard their position for the future by entering into agreements with their employees, which must be signed by the employees, authorising deductions of this sort.

Here is a specimen agreement which may be adopted:

Form of Agreement

"This Agreement is made between A. B., hereinafter called 'the employer', and C. D., hereinafter called 'the employee'.

"The employee hereby authorises the employer to deduct from his wages each week the sum of £ s. d. in respect of the cost of meals to be prepared upon the employer's premises and to be there consumed by his employee. (*Signed*) A. B. (employer), C. D. (employee)."

This form may be elaborated by using a clause to this effect:

"The employee hereby authorises the employer to deduct from his wages each week the cost of meals to be prepared upon the employer's premises and there consumed by the employee. The sum to be deducted each week shall consist of the total cost of such meals thus consumed by the employee on the premises, and shall be calculated according to the prices published in the price lists exhibited from time to time on the premises of the employer."

COAL IN THE FOOD INDUSTRY

S. J. EARDLEY

Area Combustion Engineer of the North Eastern Branch of the Coal Utilisation Joint Council

IN an article on the use of solid fuel in the Food Industry in this journal some time ago Mr. H. L. Pirie, the Chief Engineer of the Coal Utilisation Joint Council, pointed out that, although the cost of fuel and power represented only a relatively small proportion of the total cost of materials, it was, nevertheless, a substantial figure, and one which should not be overlooked when means of effecting economies were being considered.

How much more important, then, is it at the present time to scrutinise closely every item in the "costs of production" in order to ascertain whether there is room for any saving or increase in efficiency. Economies so effected in war-time not only represent a direct contribution to the national war effort, but also keep down manufacturing costs, and so help in placing the brake on the vicious spiral of ever-increasing prices.

The food, drink, and tobacco trades consume in the neighbourhood of five million tons of solid fuel a year. Much of this is burned in up-to-date plants, where the use of economisers, mechanical stokers, etc., gives very high efficiencies; but the greater part is still being burned under old-fashioned types of boiler, fired by hand (and usually by guess-work). It is not too much to suggest, therefore, that the operators of these latter plants should at least carry out an inspection of their installations, in the light of the recommendations given in this article, to see whether there is any opportunity of saving a little fuel here or increasing a steam output there. They will almost certainly be rewarded, and may even find themselves in a position to give a few helpful hints to their more fortunate associates who possess up-to-date equipment.

Generally speaking, solid fuel is used in the Food Trades primarily for steam raising, the steam being used both for power purposes and process work. The economical utilisation of fuel in any industry can be placed under two headings:

1. *Steam Generation*—the efficient use of the fuel in the boiler plant in order to obtain the largest quantity of steam for process and power purposes from the minimum quantity of coal.
2. *Steam Utilisation*—the most economical use of the steam in the factory or works.

And it is proposed in this article to describe the various methods of effecting economies and preventing waste, as they apply to the Food Industry, in this manner.

Technical Supervision

Many of the larger firms have seen the advisability, if really efficient results are to be obtained from their plant, of appointing a staff of trained engineers and fuel experts, who understand the principles of economical steam generation and utilisation. In the case of the smaller firms, however, such supervision is not usually possible, for financial reasons, and as often as not the whole process of operating the boiler plant, even to the selection and ordering of the fuel, is left to the care of the fireman.

Steam Generation

The principal types of boiler in use in the Food Industry are:

(*a*) The Lancashire shell-type boiler.
(*b*) The Economic shell-type boiler, either self-contained or in a brickwork setting.
(*c*) The Vertical shell-type boiler for the smaller-sized plant.

The Lancashire type boiler is much favoured for industrial work, on account of its reliability and simplicity. It can readily stand a heavy overload and, on account of its large water capacity, makes a good heat accumulator, so that highly varying loads can be imposed without undue fluctuation in the steam pressure.

What might be called its inherent maximum efficiency is rather low, being about 65 per cent. for the boiler alone. When fitted with modern accessories such as a mechanical stoker, superheater and economiser, efficiencies of approximately 80 per cent. can be obtained. It is improbable, however, that the average efficiency found at the majority of works exceeds 50 to 60 per cent., which means that from a quarter to a third of the fuel is being needlessly wasted in many boiler plants to-day.

Economic type boilers have a somewhat higher efficiency than the Lancashire type, giving 70 to 75 per cent. without the aid of mechanical stokers or economisers. With the addition of these modern accessories, efficiencies of 85 per cent. and over can be obtained. But these very high figures depend to a great extent upon the zeal of the operator in maintaining his plant in perfect condition and keeping a watchful eye on his meters; and, again, it is doubtful whether the average efficiency in practice to-day with the Economic type of boiler exceeds 65 per cent.

Vertical type boilers are generally used in small plants, and the average efficiency obtained is quite low.

Importance of Draught

The first principle in all good firing is to ensure that the boiler is receiving the correct quantity of air, and it cannot be too strongly emphasised that the draught, more than anything else, governs the operation of the whole plant. No amount of time spent in experimenting with draught to a boiler will be wasted if it results in better combustion of the fuel. Even complaints of undue smoke emission from a chimney can almost invariably be silenced by attention to the dampers.

If it were possible to burn coal with the ideal theoretical quantity of air—namely, 7·65 lb. of air per 10,000 B.Th.U. liberated—the flue gases would contain 18·5 to 19·5 per cent. of carbon dioxide (CO_2). In practice, however, a considerable quantity of excess air must be supplied to the furnace to ensure complete combustion of the fuel, and practical experience shows that a well-operated boiler should give flue gases containing about 12 per cent. of CO_2. If the boiler is fitted with a mechanical stoker, the figure should be about 14 per cent.

TABLE I.—PERCENTAGE OF LOSS OF HEAT IN FLUE GASES FOR VARYING AMOUNTS OF CO_2.

Temperature of Gas in Degrees F.	*Percentage of CO_2 Contained by Volume in Gases.*						
	8%	9%	10%	11%	12%	13%	14%
350	14	12	11	10	9	8	8
400	16	14	13	11	11	10	9
450	18	16	14	13	12	11	10
500	20	18	16	15	14	12	12
550	23	20	18	16	15	14	13
600	25	22	20	18	17	15	14
700	29	26	23	21	20	18	17
800	34	30	27	25	23	21	19

In Table I the percentage of heat lost in the flue gases is shown compared with the amount of CO_2 in the gas. From this it will be seen that, even with the amount of CO_2 likely to be obtained with mechanical firing, there still exists a considerable loss of heat into the flues; while if poor firing or faulty operation of the dampers reduces the CO_2 content below 10 per cent., a quarter or more of the heat available can be lost without doing any useful work in the boiler.

The type of furnace and method of firing by which the attendant can reduce the excess air to a minimum, without impairing the actual combustion of the fuel, will prove to be the most efficient.

In the absence of instruments the fireman cannot be sure of the CO_2 content of the gases, but he should endeavour to keep it as high as possible, whether firing by hand or by mechanical means. His first consideration should be for the thickness of the fuel-bed, finding from experiment the best depth for the size of coal in use; secondly, he should always regulate the dampers so that the required steam pressure is just maintained. Lack of air gives a poor fire, very often leading the operator to blame the fuel for unsatisfactory combustion; but excessive draught proves wasteful of fuel, tends to lower the steam pressure and general furnace temperature, and may, by causing unduly fast burning of the fuel, damage the fire-bars.

Depth of the Firebed

Tests conducted by the United States Bureau of Mines have shown that in the case of small anthracite there is no free oxygen in the combustion air after it has passed through an incandescent fuel-bed 4 inches in thickness. For small-sized bituminous coal a depth of 3 to 4 inches is suitable, but, as the size of the coal increases, so the bed must be deepened. In the absence of instruments the fireman can only experiment with different thicknesses and judge the results from the fuel consumption over a given period.

When the operator has adjusted the depth of the fuel-bed to give the most economical rate of burning, he should turn his attention to the draught being admitted to the fire and experiment in the setting of the dampers. Table II gives the approximate draughts (in inches water gauge) necessary at the side flue dampers of a Lancashire boiler for various rates of coal combustion (measured in lb. of coal per square foot of grate area per hour).

Advantages of Meters

The introduction into the boiler-house of one or two measuring instruments can prove a great assistance to the attendant in obtaining the best possible results from his plant, and will also prove its worth to the management as a means of checking fuel consumption and the efficiency of the plant and the operating staff.

TABLE II.—DRAUGHT FOR VARIOUS RATES OF COMBUSTION.

Method of Firing.	*Rate of Combustion. Lbs. of Coal per Sq. Ft. of Grate Area per Hour.*				
	20	25	30	35	40
	Draught in Inches Water Gauge at Boiler Dampers.				
Bituminous Coal Hand-fired	0·4	0·55	0·65	0·88	1·2
Bituminous Coal, Mechanically Fired, Forced Draught ...	0·38	0·45	0·55	0·76	1·08

A thermometer fitted to the economiser or to the exit flue shows whether the tubes are being kept clean and permitting the full amount of heat to be transmitted to the water. Draught gauges enable a constant watch to be kept on the quantity of air being admitted to the furnace, and indicate when any accumulation of flue dust begins to impede the air. The use of a feed water meter and a weekly record of the cold-water ratio will prove a ready guide to the overall efficiency of the plant. If the cold-water ratio is low it is time to inspect the boiler.

Feed Water

The very considerable saving in fuel consumption that can be effected by the use of heated feed water is not fully appreciated. By raising the temperature of the feed water before it enters the boiler 10° F., the efficiency of the boiler is increased by 1 per cent. By the use of an economiser, in which the waste heat in the flue gases is utilised to heat the feed water, the temperature can be raised by 100° F. or more, thereby giving a direct increase in efficiency of 10 per cent.—an increase that can be realised in hard cash by the fuel saved.

TABLE III.—SAVINGS EFFECTED BY THE USE OF AN ECONOMISER.

	Heat Supplied by Boiler without Economiser.	*Heat Supplied by Boiler with Economiser.*
(*a*) Boiler pressure ...	125 lb. per sq. in.	125 lb. per sq. in.
(*b*) Boiler feed water temperature ...	120° F.	280° F.
(*c*) Heat of steam from boiler (above 32° F.)	1,197 B.T.U./lb.	1,197 B.T.U./lb.
(*d*) Heat supplied by feed water (above 32° F.)	88 ,,	248 ,,
(*e*) Net heat supplied by boiler	1,109 ,,	949 ,,
Saving effected by economiser per lb. of water evaporated		1,109 – 949 B.T.U./lb. = 160 B.T.U./lb. or 14·43 per cent.

Table III shows the saving that can be effected by the installation of an economiser, amounting in this case to nearly 15 per cent.

A special design of economiser is now being supplied for use in conjunction with boilers of the Economic type. It has been found that with the comparatively high temperatures used in this kind of boiler—from 650° to

720°—there is still a considerable amount of heat going to waste, despite the higher overall efficiency of the Economic as against the Lancashire type of boiler.

Periodic Inspection

In order to ascertain whether a boiler plant is giving the maximum possible efficiency, a general running test should be carried out. If the efficiency proves to be low, attention should first be given to the possibility of cold air leaking into the combustion chamber and "killing" the draught. Air leaks will usually be found round the brickwork setting and by the damper frames. In the case of a Lancashire boiler a frequent source of leakage is between the back wall and the boiler back, and round the front wall and boiler shell, the former allowing the gases to short circuit directly into the side flues.

There are several firms which specialise in the manufacture of special air-tight fittings and expansion settings for Lancashire and shell-type boilers and covers for damper frames, and the small outlay involved in the purchase of one or more of these appliances will soon be returned in the form of better boiler efficiency, lower coal consumption, and, as often as not, less smoke production.

While carrying out running tests the state of the fuel on the grate should be inspected. Any holes in the fire allow large volumes of air to enter the furnace, and, if the boiler is working under a heavy load, this lowers the steam pressure and helps the formation of clinker.

All the surfaces of the boiler should be inspected and cleaned, and careful attention given to the state of the flues.

If the general running test has revealed a number of faults, and these have been rectified, it should not be assumed that the boiler will continue to operate efficiently for ever after. It is as well to organise periodic inspections of the whole plant. Running tests should be carried out regularly and a thorough inspection made whenever the furnace is out—*e.g.*, during holidays and wakes. In this way the plant will always be maintained at a high level of efficiency and the operating staff kept on the alert.

Alternative Fuels

According to a Board of Trade Survey taken in 1935, the annual consumption of imported fuel oil in the food, drink, and tobacco trades amounted to over 130,000 tons. When the war started many firms using liquid fuel must have wondered whether it was altogether wise to have preferred the apparent labour-saving advantages of imported oil to the claims of home-produced solid fuel. There seems little doubt, however, that those firms which decide to make the conversion from oil to coal for the duration of the war will not feel inclined to change back again. Fired under up-to-date conditions, solid fuel is clean, efficient and cheap, and consumers of coal will not find themselves in the course of the present emergency at the mercy of runaway prices—in the last war the price of fuel oil increased by many hundred per cent.

Many coal consumers may have found themselves faced during the last few months with the prospect of burning grades of coal which they would not normally have used. They need have no cause to worry. While every boiler naturally has its ideal fuel, many of the lower grades can be used if a little trouble is first taken to ascertain how best to burn them. Slacks and small coal can be used quite satisfactorily for hand firing and in many mechanical stokers. Experiments carried out with the thickness of the fire-bed and the intensity of the draught will soon give an economical state of firing. Small sizes of coke can also be used with confidence on suitably designed forced-draught furnaces.

It may also be found that some of the alternative coals available nowadays have a rather higher ash content than those to which the consumer is accustomed. But the presence of ash, even to the extent of 8 to 10 per cent., does not affect boiler performance very much; and the substitution of a fuel containing 9 per cent. of ash for one with, say, 6 per cent., should not have any serious effect on the operation of the plant. In fact, ash is sometimes a blessing in disguise, as it furnishes a refractory covering for the fire-bars and prevents undue burning of the metal.

Mechanical Stokers

In order to secure economical and smokeless combustion with hand firing, a certain degree of skill and intelligence is required of the fireman. As in the majority of cases finance does not permit of the payment of a skilled operator, the introduction of mechanical stokers at reasonable prices enables the management of the smallest factory to use the services of unskilled labour without allowing the efficiency of the plant to suffer.

It is comparatively seldom that a new factory is erected which does not rely in some way upon mechanical stokers, and every month existing plants are being converted to automatic firing. The reasons for the great popularity of mechanical stokers may be briefly summarised as follows:

(*a*) Very much larger outputs can be obtained for any given size of boiler than with hand firing.

(*b*) Higher efficiencies can be obtained. The fuel-bed can always be maintained at the correct depth, thereby reducing the excess air required for complete combustion to a minimum. In addition, the furnace is not disturbed by continual opening of the fire-door.

(*c*) Hand firing of bituminous coal on heavily loaded boilers may result in smoke emission. A suitable type of mechanical stoker will burn the same class of fuel smokelessly. Automatic stokers are designed to feed the coal to the furnace continuously in small quantities, eliminating the smoke produced when a large quantity of raw coal is placed upon a fire at a time.

(*d*) Fine fuels that are quite unsuitable for hand firing can be burned in furnaces equipped with automatic stokers and forced draught.

There are three main types of mechanical stoker, suitable either for shell-type boilers or those of the Lancashire and Economic type:

Coking Type.—This stoker imitates the coking system of hand firing. The grade of fuel best suited for this type of stoker is sized free-burning or slightly caking bituminous coal of not more than 1¼ inches cube. Induced draught is usually required.

Sprinkler Type.—With this type the spreading motion of hand firing is followed, distributing the fuel evenly over the whole area of the fuel-bed. A fairly wide range of fuels may be used, from 0-inch to ½-inch smalls to 1-inch to 2-inch doubles. Sprinkler stokers can be supplied either for induced- or forced-draught operation.

Underfeed Type.—With this type the fuel is fed to the fire from below, so that the volatiles from the raw coal, which cause smoke, are consumed on their way through the incandescent fuel bed. The stoker is designed for burning bituminous coal smokelessly, and in order to obtain the best results a sized, free-burning, non-caking coal should be used.

The underfeed type of stoker is very often fitted to vertical boilers, and, although the best results are to be obtained with a really free-burning coal, a slightly

caking slack can be used, provided the fire is broken up a little more frequently.

Steam Utilisation

The best boiler in the world, fired at its maximum efficiency, is of little value in a factory if the steam is carelessly used or wasted before its work is done, and any fireman knows that all his efforts at good firing can be set at nought by a faulty steam pipe or poor lagging. It would be wise, therefore, for works managers to include in the general running test of the boiler plant an inspection of the delivery pipes and jackets, to ensure that the steam which they are at pains to generate is being utilised to the fullest advantage.

Value of Lagging

Serious wastage frequently occurs in the transmission of steam through the factory if the pipes are unlagged. Under ordinary conditions every square foot of unlagged boiler or pipe surface loses as much as 3 B.Th.U. per hour per degree of difference between the temperature of the steam in the pipe and that of the outside atmosphere. For a 6-inch unlagged steam pipe the preventable loss per 100-foot run may represent over 50 tons of fuel a year.

In food factories extensive use is made of heating vessels and boiling pans, which are either steam-jacketed or use steam for heating in one way or another. It is essential that these vessels should be lagged with suitable insulating material, as the loss of heat by condensation and radiation from the large areas of metal can be very high.

Other common sources of loss of steam and heat are:

(*a*) Steam escaping from faulty joints or valves.
(*b*) Open-ended discharge pipes from steam-jacketed vessels.
(*c*) Condensate from these vessels running to waste.

All heating vessels of this type should be fitted with a steam trap and provided with a condensate return to the boiler feed water tank. It is quite a simple matter to lag the return pipes and to return condensate to the feed tank at a temperature of 150° to 160°, thereby reducing the amount of make-up water required and considerably lowering the fuel consumption.

When there is a source of exhaust steam available from engines and pumps, it can be utilised for heating water, process work or augmenting the work of the economiser in heating feed water.

Using Steam Twice

In the case of food factories, where most of the steam is used at low pressures, an excellent case can be made for the installation of a generator to provide all power requirements without outside aid, and the utilisation of the exhaust steam for the process work. By thus using the steam twice over considerable economies are effected, while the advantages of a self-contained power unit in times of emergency, and especially during air raids, speak for themselves.

Just as the boiler-house will benefit from the introduction of measuring instruments, so the installation of thermometers and meters throughout the plant will pay for itself many times over in increased efficiency and the prevention of waste. In large factories the presence of a steam meter in each department assists the costing section in assessing each department with its correct proportion of the fuel and power charges. It will also be found that meters have a very happy psychological effect on the boiler-house staff.

In this article an attempt has been made to show some of the chief sources of lost efficiency and wasted fuel in boiler plants. Occasionally inspection of the plant may reveal serious faults involving the replacement of part of the plant, but in the majority of cases it will be found that there is no one single cause for poor performance, but that the sum of all the small faults adds up to a surprisingly large proportion of the fuel costs.

Correspondence

SUGAR RATIONING FOR BAKERS

The Editor.

DEAR SIR,

As one of the largest suppliers of margarine to the bakery trade, we were naturally interested in your editorial comments about the effect of the rationing of sugar on this industry and in your suggestions for the alleviation of the difficulties arising from it.

We would like to support your view that syrup, glucose and honey can be used, and, as many bakers have fair stocks of these commodities, we have no doubt that a considerable use will be made of them. A word of warning is necessary, however, because it is *not* possible to replace castor or other crystal form of sugar with either syrup, glucose or honey on a weight-for-weight basis. Experiments by our service bakery staff indicate that the syrup, etc., is best used in the form of a stock syrup balanced to give a constant sucrose equivalent, because, in this way, one overcomes the difficulty of constant re-balancing of the recipes to suit changes in the raw material. The method also avoids frequent changes in cake-making technique, because it is not practicable to cream the syrup or glucose in the sugar-fat batter. We have devised a series of suitable stock syrup recipes for use in a wide series of cake recipes, and these recipes are available to the bakery trade on request—the interest of bakers in them is revealed by the fact that during February alone we received over 3,000 inquiries.

The further suggestion in your editorial regarding the reduction in sugar in recipes is a good one, but we are anxious that all your readers shall understand that such a reduction may materially change the character of the finished article if the recipe is not modified in other ways also. We have been experimenting for some years on recipe balance, and our past experience has been of great value in determining the character and extent of the modifications necessary.

We are, therefore, able to re-balance recipes in such a way as to effect a considerable economy in sugar, and, provided the economy is not excessive, we can retain the characteristics of the original finished article.

Our experiments have also given us information on the methods of effecting economies in other ingredients such as eggs, margarine, etc., and this information, as many of your readers will already know, has been released to the trade through public demonstrations and the Craigmillar War-Time Bulletins.

We believe that the use of such modifications, combined with a careful survey of the types of cakes, etc., made, and the elimination of uneconomical recipes, will permit bakers to maintain, and even increase, their turnover despite the restrictions on raw material supplies. We are sure that information such as you have given and such as we have made and are making available, will be of considerable help, and we would like to say that our assistance is at the disposal of your readers.

Yours faithfully,
THE CRAIGMILLAR CREAMERY CO., LTD.,

BOILER HOUSE

PLANT AND EQUIPMENT

A Symposium

MECHANICAL STOKERS

Sprinkler Type

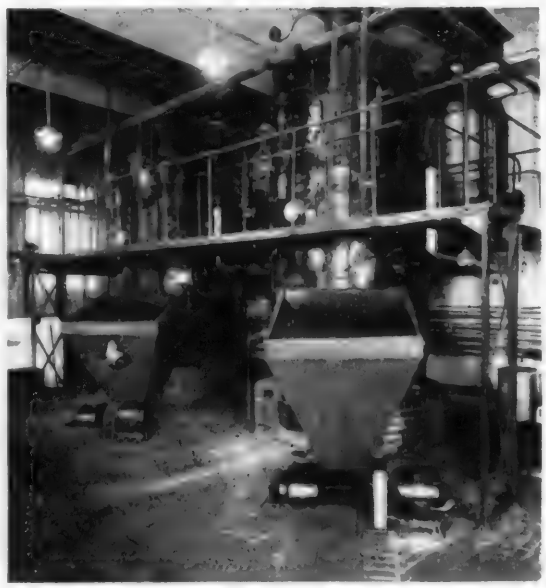
THE Niagara Stoker is of the sprinkler type. The coal is thrown on to the furnace by means of flexibly hinged blades constructed of manganese steel throughout. These blades are right- and left-handed, and so arranged that a uniform fire will be built up and maintained. This flexibility permits the passing of any obstruction or foreign matter which may find its way into the stoker, making it impossible to jam or damage the machine in any way. This is a novel feature not incorporated in any other make of stoker.

The rotor shaft, which revolves at approximately 250 r.p.m., is geared to an eccentric, which in turn actuates a feed-dog. This latter component is linked to the feed-plate by means of a latch, and the distance of travel of the feed-plate can be regulated to an infinite degree, enabling any required rate of coal feed to be obtained.

Each machine is separately controlled and the fuel feed may be varied to within 1 per cent. With this design stepped pulleys and gear changes are eliminated, the limit of control not being confined to three or four different speeds as with many types of stoker.

A unique secondary air system keeps the whole machine, front, and firedoor exceptionally cool, and provides pre-heated air to promote combustion.

Stokers can be supplied to operate with natural, induced, or forced draught, and grates are provided to suit individual requirements. The machines will handle a very wide variety of fuels, including many which have been found unsuitable with other types of stoking equipment. In case of emergency the furnaces can always be hand-fired, thus ensuring that the steam service is not interrupted by electrical breakdown.

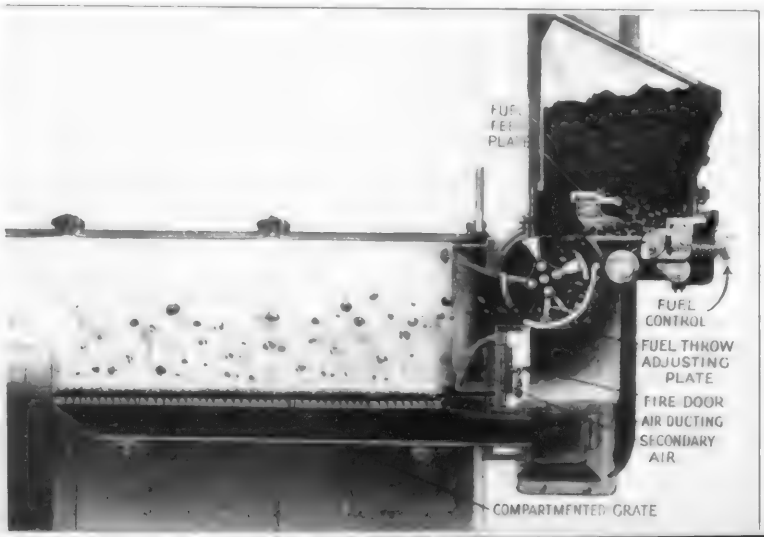


A "Hope" Motor Stoker.

The whole plant is exceptionally robust in construction, with few moving parts to give rise to wear and tear. It is an established fact that many Niagara Stoker installations have given over three years' continuous service day and night under the most severe conditions of load without incurring any breakdown or renewal costs.

The Niagara Stoker is British in design, and manufactured by the Smokeless Combustion Co., Ltd., from British materials and labour throughout.

Niagara Air Draught Stoker showing application to a Lancashire Type Boiler.



The Motor Stoker

The maintenance and control of uniform temperatures are essentials for the food manufacturer, both in the factory and in the storage plant. These essentials are ensured by installing a "Hope" Motor Stoker (Hope's Heating and Lighting, Ltd.), and can then be maintained at lowest possible operating costs.

The importance of clean working and controlled uniform temperatures is given first attention, and in all their installations Hope's maintain the closest co-operation with other equipment experts who are interested.

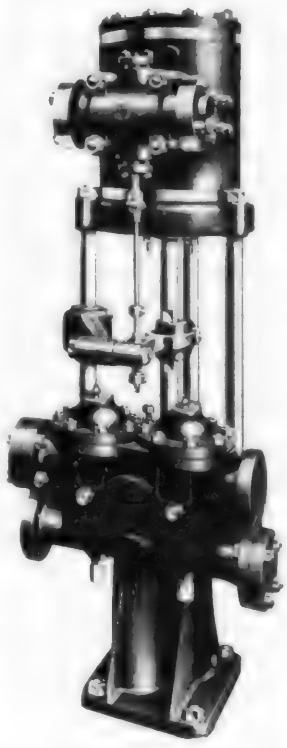
Mechanical stoking is now generally accepted as the

most efficient method of firing in any type of boiler; it is acknowledged that a stoker will reduce fuel costs and at the same time increase the general all-round efficiency of any plant from a simple central heating and hot-water supply installation to a highly specialised industrial process.

The "Hope" Mechanical Stoker has reached its present state of perfection after many years' experience in coal combustion problems; it is not, therefore, an experiment.

PUMPS

Boiler Feed Pumps



The Worthington-Simpson Vertical Simplex Boiler Feed Pump is fitted with Steam Valve Gear of great simplicity, and is an easily operated mechanism. The working parts consist of a main slide valve, a steam-thrown plunger, and a small auxiliary-slide valve. The three parts, together with the valve rod connections to the lever, which move the auxiliary valve, make up the whole working mechanism. It is particularly adapted for operation with high-pressure steam, the auxiliary valve being the only working part directly connected to the valve rod, which valve, due to its small area, is subject to but little friction from the pressure of steam upon it, and consequently the strain and wear on the connections, which are encountered in some types, are eliminated. In the Worthington-Simpson Vertical Simplex Boiler Feed Pumps the main point in connection with the pump end is in the arrangement of the pump valves. In the 7 in. by 5 in. by 12 in. size and upwards, the suction and delivery valve seats are formed in plates, which plates are separate from the pump casting and are arranged with valves, guards and springs on one spindle. By this grouping arrangement the whole of the suction and delivery valve service for each side of the pump forms a complete unit and therefore can be taken out for renewal or inspection and replaced with a minimum expenditure of time and trouble.

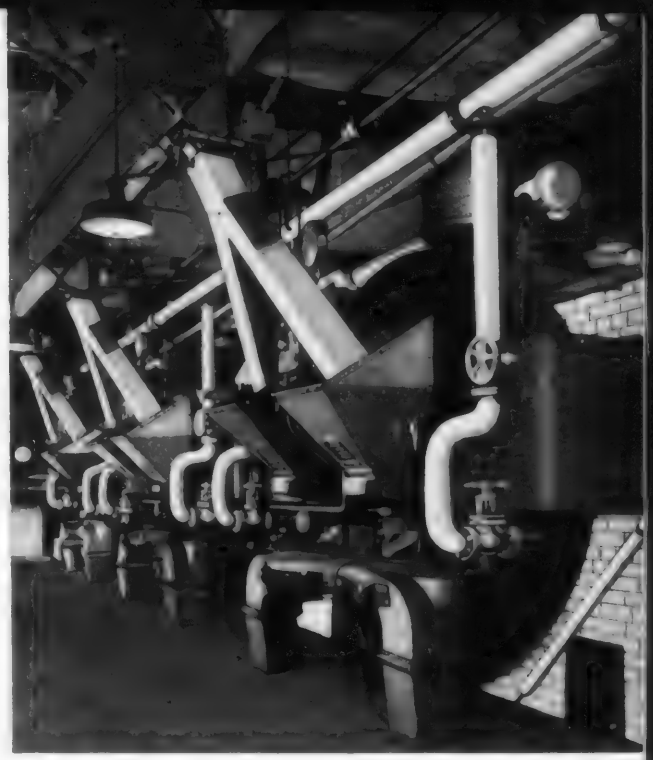
ECONOMISERS

Gilled-Tube Type Economiser

The amount of the waste heat which can be recovered by the use of an economiser depends upon the amount of economiser heating surface which is installed and its cleanness, since the presence of soot and dirt deposit seriously retards the passage of heat to the water. For this reason either mechanical scrapers or soot blowers are usually installed for cleaning the heating surface; though with soot blowers the economiser is at the maximum efficiency only immediately after soot blowing, the transmission of heat being steadily lowered with accumulating dirt until the next operation.

To overcome this difficulty the Senior H-type gilled-tube economiser element was evolved by Senior Economisers, Ltd., and has proved that the plant can be made virtually self-cleaning. The tube elements consist of high-grade cast-iron tubes connected by bends. The gas passages are formed by straight gills cast on the tubes, so formed that when the elements are assembled the passages for conveying the hot gases are straight and uniform in cross-section throughout. The draught loss is therefore reduced to the minimum, and deposition of dirt from the gases is avoided, as any which contacts the gills heating surface is swept off and carried out of the economiser. Although soot-blowers are sometimes installed with these economisers as a precautionary measure, they require to be used only at infrequent intervals. Should it be necessary to remove a tube element for any reason, it can be withdrawn and replaced very easily without disturbing the adjacent elements.

The maintained efficiency of heat recovery which is ensured by this construction enables substantial economy in fuel consumption to be effected. In some industrial plants savings as great as 16 per cent. have been recorded.



The absolute necessity for the conservation of the national coal supply, coupled with the fact that previously unsaleable classes of small waste fuels must be utilised, make it incumbent on those responsible for the production of steam to give careful consideration to the incontestable benefits to be derived from the installation of mechanical stokers, combined with coal and ash handling plant.

Bennis Combustion, Ltd.

Valveless Rotary Plunger Pumps

The P Type Pump is a valveless rotary plunger pump for pumping viscous liquids at high or low pressures.

Owing to its special construction (positive action, absence of vibration and having no valves) it can deal satisfactorily with:

Glucose, Cellulose, Enamels, Paints, Oils (lubricating and fuel), Glycerine, Glue Gum, Gum, Margarine, Viscose, Chocolate, Molasses, Syrups.

The pump can be supplied direct coupled to electric motors or engines. Self-priming on 25 feet suction. Pressures up to 250 lb. per sq. in.

The Oyl Pump is for oil and other viscous lquids, but for higher pressures than the Pulsometer P Type. It is highly efficient, positive in action at all speeds, self-priming on 25 feet suction, valveless and no valves required in pipe lines; can be completely dismantled without breaking pipe joints and fitted with "Pulsometer" patented self-sealing leak-proof gland. The motive power is applied direct from shaft to liquid without the intervention of any frictional surfaces. The pump is robust, simple in construction, with few working parts.

FUEL OIL STRAINERS

Auto-Klean self-cleaning strainers are to be found on all modern equipment using fuel oil.

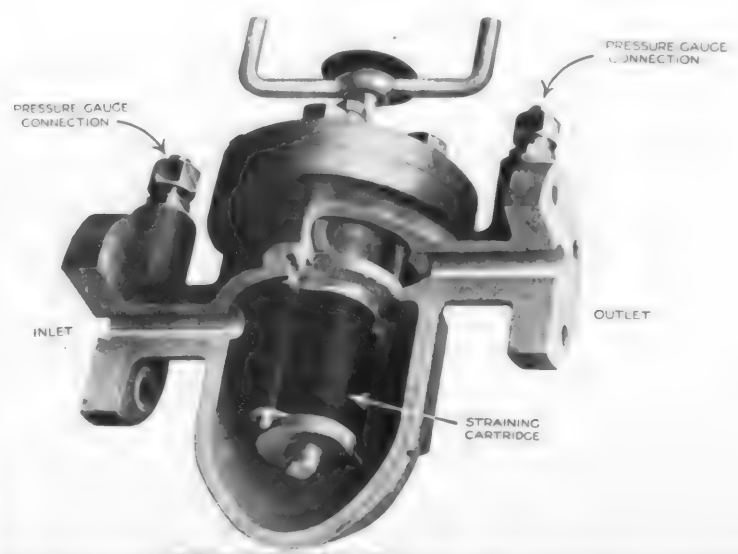
Strainers available for this duty range from large high-pressure units capable of dealing with thousands of gallons of boiler fuel oil per hour at working pressures of 250 lb. per sq. in., down to small low-pressure units for use in connection with oil burners for small heating installations.

The main feature of these strainers is that they are completely cleaned by turning a handle. They need never be opened up for cleaning while the system is in operation. Fire risk from this cause is therefore eliminated and any inconvenient shut-down due to choked strainers causing fuel starvation is avoided.

The straining element consists of a pack of metal plates accurately spaced apart by intervening washers to form straining slots. This pack is assembled on to a spindle which can be rotated by an external handle. A series of cleaning blades are assembled on to a fixed rod lying along the straining element and each blade enters one of the straining slots.

Dirty oil passes through the slots leaving all foreign matter on the outside of the straining element. When the handle is turned the plates are revolved against the stationary cleaning blades which completely clean each slot. The dirt falls into a large sump from which it can be removed at any convenient time.

Meshes from 0·003 in. upwards are available, and strainers can be supplied in any materials to suit special conditions. Made by Auto-Klean Strainers, Ltd.



SECTION THROUGH STRAINER

INSULATION

Conditions in water tube boiler furnaces are so severe that it is essential to use high grade refractories for the arches and side walls. The "Alite D" high alumina firebricks, manufactured by E. J. and J. Pearson, Ltd., are a proved success both for "sprung" arches of the old type, and also for the more modern flat suspended arches.

Asbestos cushioned seating blocks and flue covers are most efficient and economical for Lancashire boilers. With this system all boiler plates are completely insulated from contact with the blocks and covers. The asbestos rope is compressed into a groove in the block and the boiler plates are secured from rubbing due to expansion and contraction of the boiler.

Seam inspection blocks and covers are specially designed to facilitate complete examination of the ring-seams of the boiler.

VALVES

Telco Valve and Position Indicator

The Telco Seat-in-Sleeve Valve has been specially designed to eliminate the commonest cause of leaking valves—namely, the wear of the seat through the cutting action of "wire drawing" of the steam. The stainless steel seat is protected by a sleeve in which the valve clack moves. Ports are cut in the sleeve so that no steam passes until the valve clack clears the ports. The clack is then well clear of the seat, and all the wear due to the sudden rush of steam is taken by the sleeve. No matter how worn the ports in the sleeve become, the valve will shut tight when screwed down on the seat.

In process work many valves are working in the "cracked" position—that is, with the valve only just open to allow the passage of a very small quantity of steam. As the steam is passing through a very narrow opening, "wire drawing" occurs, and consequently a valve which is used in the cracked position will wear far more rapidly than one which is used wide open. The Telco Valve is particularly suitable for such applications. With the valve just opened it is possible to get very fine regulation, owing to the design of the ports, and at the same time there is no wear on the seat, but only on the sleeve. For example, in heating jacketed pans, the valve is first fully opened to bring the contents of the pan to the boil, and is then shut down to the cracked position to maintain the boiling.

Telco Valves are manufactured in two types: Type "B" for saturated steam up to 150 lb. pressure, and Type "D" for superheated steam up to 650° F. and 300 lb. pressure. They are available in all the usual pipe sizes, with screwed or flanged connections.

Where valve setting is important it is always a problem to ensure that correct setting is obtained. Usually the foreman or some other responsible person has to spend a good deal of time inspecting each valve to make sure that it is at the right opening. All this wasteful trouble and guesswork is eliminated by fitting the Telco Valve Position Indicator. This indicator takes the place of the ordinary hand wheel and incorporates a dial, suitably graduated, over which a red disc moves, indicating the opening of the valve. The operator merely has to open the valve until the indicator shows the correct position. The indicator is very easily read, and even from a distance one can see at a glance the exact position of the valve.

The Telco Valve Position Indicator is being increasingly used on steam valves on heating coils, jacketed pans, etc., on fuel oil valves to oil burners, and gas valves to gas furnaces. It can be fitted to any type of valve up to 1 in. in size. This is being manufactured and marketed by Walker, Crosweller and Co., Ltd.

BOILER CONTROL INSTRUMENTS

Flowmeters and Heat Loss Recorders

A float type steam flowmeter works on the mercury manometer principle and is suitable for measuring the flow of steam, etc., such as is used in various food preparation processes. It can be supplied for Indicating, Recording and Integrating, with distant transmission of the readings, if desired. Suitable for working pressures up to 1,000 lb. per sq. inch.

The Combustion Heat Loss Recorder has been designed as a unique, direct-reading recorder for the combustion engineer and ensures fuel economy in the boiler house. A CO_2 meter, although giving information concerning the combustion of the fuel, does not always indicate the best thermal operating conditions. Its readings are a measure of the excess air, but it does not take into account the variations of the flue gas temperature. The combustion heat loss, however, can be calculated from the CO_2 and temperature of the flue gases. Rosin and Fehling have shown how this may be done in their heat-temperature diagram.

A close approximation can be obtained from the Siegert formula:

$$\% \text{ Heat Loss} = \frac{K\ (T-t)}{C}$$

where K is a constant dependent on the kind of fuel,
T is the flue gas temp.,
t is the temp. of the air entering the furnace,
and C the percentage of CO_2 by volume.

These principles, together with the results of a great number of tests, have been utilised in the production of an instrument reading directly the percentage of combustion heat loss. The instrument consists of an electrical CO_2 transmitter and pyrometer stems, whose readings are combined in a recorder with a special cross coil movement.

The instrument has the advantage that an increased significance is imparted to a comparatively small change in CO_2 and flue gas temperature readings.

For example, for a certain grade of fuel, a change from 12 per cent. to 10 per cent. CO_2 and 480° to 370° F. means an increase of 6 per cent. in heat loss which corresponds on this instrument to more than one-third of the total length of the scale, whereas, measured on separate CO_2 and Temperature Indicators, only about one-tenth of the scale would be involved. The instrument therefore draws immediate attention to any slight departure from correct working conditions.

It supplies a definite need in boiler equipment, whereby, in drawing immediate attention to alterations in working conditions, the combustion engineer is enabled to detect incorrect firing or faulty operation of plant without the necessity of making continuous calculation. These instruments are manufactured by Elliott Brothers (London), Ltd.

Control for Small Boiler Plants

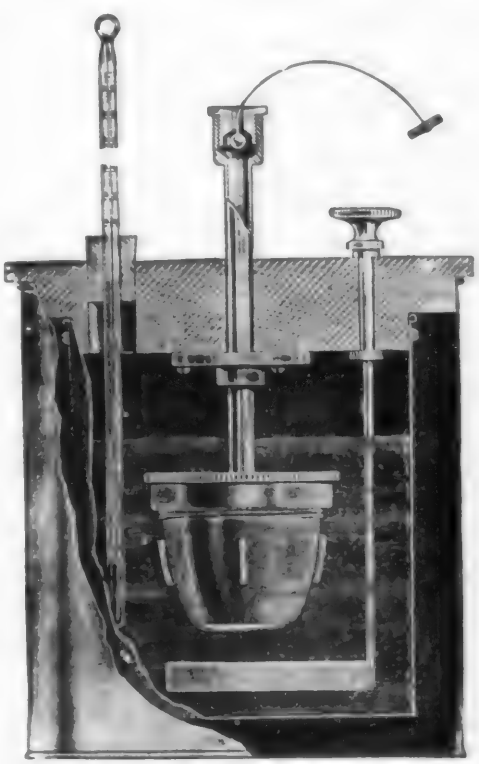
A considerable interest has been displayed in the automatic control equipment available for small boiler plants similar to those installed in many food factories throughout the country. This is very largely due to the increased cost of fuel and the need for economising wherever possible in the basic costs of production.

A well-designed automatic combustion control system will effect substantial economies in fuel consumption and will generally increase efficiency of the boiler plant. The economies are of such a nature that the initial cost of the installation can be recovered in about twelve to eighteen months' operation. Further, the maintenance costs of the boiler plant will be reduced, as the automatic control system operates the plant with minute and accurate adjustments, and violent fluctuations in draught and furnace temperature, etc., do not occur. The equipment is not expensive, and can be applied to Lancashire boilers and small water-tube boilers. It can be supplied in either complete or partial form, depending upon the type of plant under consideration, and its operation is so simple that the boiler-house staff can understand it and carry out the necessary small amount of maintenance with ease. Detailed particulars as regards the type of controllers employed, and their operation, are given in the company's booklets Nos. 868 and 874. In conjunction with the above-mentioned automatic control system they also supply instruments which can be of flush-mounting type, giving records or an indication of the water flow to the boilers and steam flow from boilers. The KM Meter shown in this catalogue is also extensively used for steam measurement to the various processes involved in food manufacture. Other boiler-house instruments include draught and pressure gauges, also of the flush-mounting type.

Kent Meters, made by George Kent, Ltd., are being used by various food manufacturers, including sugar companies, biscuit manufacturers, chocolate manufacturers, margarine manufacturers and many others.

Calorimeters

Solid fuel has resumed its historic place in the national economy and assumes a still greater importance as the rational alternative to imported fuel oils. The chief solid fuels, coal and coke, cannot in these times always be relied upon to be of constant quality in view of the exigencies of production and distribution. The basis of the Heat Balance Sheet, however, must remain the



"B.T.U. input", so that it becomes very necessary for industrial manufacturers to adopt means for determining calorific value of fuel supplies.

The "Roland Wild" Calorimeter, made by Alexander Wright and Co., Ltd., has been developed specially to meet the needs of industrial users. It is of the sodium-peroxide type, so that a separate oxygen supply is not needed, and the combustion is made under low pressure. It is simple to use, gives reliable results, and can be arranged for electrical firing and mechanical stirring. Two other types are made.

The company also makes a variey of Draught Gauges ranging from simple U-tube and inclined gauges to multi-point banks of aneroid (dry) type gauges; also similar instruments for gas pressure and vacua, and recording types. CO_2 Recorders and Indicators are other products of this firm.

AIR CONTROL AND DUST SEPARATORS

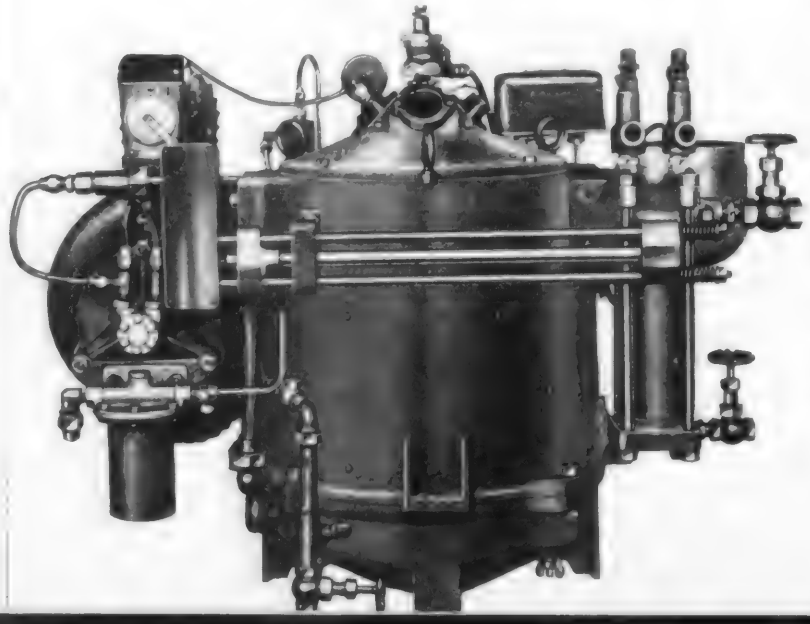
The increase in production in all branches of industry to cope with war-time requirements has necessitated substantially greater loading on most boiler plants, and this, together with the use of cheaper grades of fuel, has made grit emission a matter of grave concern to many plant engineers.

A new device for dust collecting which has only lately been available in this country seems to be ideal for the purpose; this is the Rotoclone Combined Induced Draught Fan and dynamic dust separator.

The Rotoclone consists essentially of a special impeller designed to give a high dust separation and casing constructed with two separate scrolls, one functioning as a normal fan casing and delivering the cleaned flue gases to the stack, the second scroll forming a dust chamber to receive dust separated out from the flue gases when passing through the Rotoclone impeller. In order to simplify the depositing of the dust in a convenient position, the dust stream from the secondary scroll is led to a secondary cyclone placed over a hopper or other means of collecting the dust. The cleaned gases from the secondary cyclone are led back to the inlet of the Rotoclone. Therefore, the efficiency of the cyclone has no bearing on the dust collecting efficiency of the plant as a whole. Any dust passing the secondary cyclone is automatically re-separated in the main Rotoclone unit.

This apparatus therefore performs the duties of both induced draught fan and dust collecting plant while taking up little more space than a normal induced draught fan, and at a comparatively small extra cost.

The patent rights in this country have been acquired by Air Control Installations, Ltd.



Near and Remote Control

Many types are manufactured by James Gordon and Co., Ltd., under the name Hagan Automatic Control.

The Hagan Automatic Boiler Control for regulating draught, fuel and air in accordance with steam demand is claimed to pay for cost of installation in fuel savings in a short time. The steam pressure is kept constant even with large load fluctuations, and the equipment is applicable to Watertube and Lancashire Boilers and to any method of firing or fuel. Hagan Remote Control is for operation from a distance of Dampers, Doors, Valves, etc., and is suitable for centralised control of boilers and all types of furnaces. Among the many other installations undertaken by the firm are those for steam pressure reduction and/or de-superheating; separators for steam, compressed air and gases which effects the complete removal of moisture, oil and other impurities; Gordon steam superheaters; Oil Cooler and a new Mono Combustion Recorder, made in two types, one which records CO_2 only and one which records both CO_2 and unburnt gases (CO and H_2) in products of combustion.

STEAM GENERATORS

Oil Fired Generator

The Vapour Clarkson Steam Generator has recently been introduced into this country by Messrs. Gresham and Craven, Ltd., under manufacturing licence from the Vapor Car Company of Chicago, U.S.A.

It is an oil fired generator of the continuous water-tube type, and is designed for a capacity of 300 lb. of steam per hour at pressures up to 200 lb. per sq. in. The steam generation is instantaneous and full working pressure is attained in about three minutes.

The construction incorporates a patented staggered coil assembly which is properly compensated for expansion and designed to split the combustion gases into narrow films which flow freely in the opposite direction from the flow of water in the coils. The resulting heat release of over 1,000,000 B.T.U.'s per cubic foot combustion space ensures an exceptional steam delivery for the size of the equipment.

The capacity of the generator is automatically variable from 100 to 300 lb. per hour of dry or superheated steam, and the degree of superheat is adjustable up to 500°-600° F.

Diesel fuel oil is used, the consumption being as low as 1 lb. per 10 to 12 lb. steam, while the power required for driving at 300 lb. capacity is approximately ½ h.p., supplied alternatively from a small electric motor or internal combustion engine.

Fully automatic safety devices are incorporated in the design which eliminate any possibility of damage from failure of the fuel or water supply, the ignition or overheating from any cause.

The set can be arranged to furnish hot pressure fluids in addition to steam, and is alternatively available as a supply of low-pressure hot water only.

The weight of the set complete with electrical equipment is 580 lb. and the floor space needed only 24 in. by 36 in.

It is therefore quite adaptable as a portable as well as a stationary set, and is available mounted on a motor trailer complete with incorporated fuel and water tanks.

STEAM TRAPS

The Spirax Trap

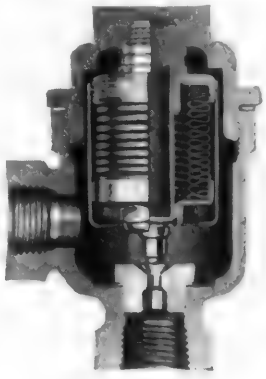
The discharge capacity of any steam trap depends upon (amongst other things) the difference of pressure between the inlet to the trap and the outlet from the trap, but this does not infer that traps should be selected on the basis of their inlet and outlet diameters.

The only satisfactory basis for selection of types and sizes of traps is on their capacities.

In considering this, it is necessary first of all to bear in mind that the capacity of a trap varies with the steam pressure—the greater the pressure the greater the capacity.

When calculating trap sizes for boiling pans it is safer to use condensing areas rather than pan capacities, because pan capacities have no direct bearing on the steam condensing surface. The steam condensing rate depends upon the sizes of the condensing surfaces and the differences in temperature.

In choosing the right kind of trap for pan installations it is necessary to calculate the quantity of steam required to bring about a certain boil. There is more than one method of doing this, but there is not space here to detail each (the necessary data is available in the Spirax Trapping Bulletin, "The Draining of Steam-Jacketed Pans", issued by the Spirax Manufacturing Co., Ltd.). After calculating the quantity of steam required, a second calculation is necessary to find out the maximum condensation rate in order to choose the right kind of trap.



Spirax 9-200.

In the matter of condensation rates, however, boiling pans differ, and a number of factors have to be taken into account before arriving finally at the figure representing the peak load per hour at a given steam pressure. This final figure denotes the capacity of the trap required for the job. The various stages of calculation are dealt with in the Bulletin named above.

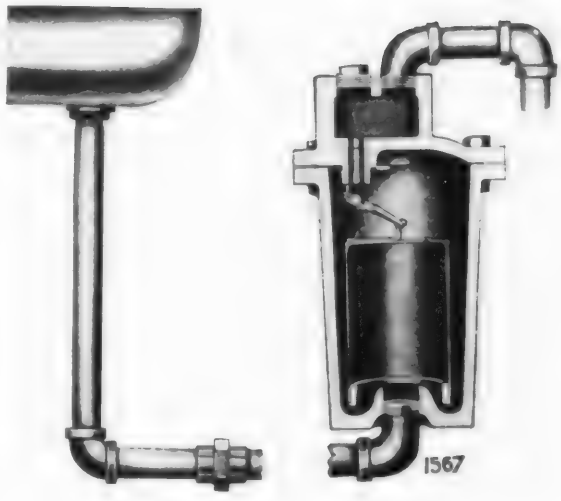
The Spirax 9-200, which is for general purposes, is a self-adjusting thermostatic trap for pressures up to 200 lb. per square inch. It is very economical, because it discharges condensate below steam temperatures and does not waste steam radiation owing to its extremely small size.

Inverted Bucket Type

The particular design feature of the Drayton/Armstrong, of the inverted bucket type, trap being the floating construction of the valve lever. At the butt end the lever is loosely located by two guide pins projecting downwards from the cover and passing through holes in ears formed on the lever at each side of the valve proper. The lever moves freely on the guide pins so that it swings into the horizontal position as the bucket rises and the valve approaches the valve seat thereafter with a straight vertical lift.

As the bucket is attached to the lever by means of a hooked strap passing freely through a slot, the valve closes with a snap action, the lever and valve being lifted bodily into the full closed position by the upward current of the outgoing condensate.

The valve is held closed by the pressure in the trap



body until the bucket has fallen to the position in which the hook of the strap engages on the end of the valve lever. Further downward bucket movement tugs the valve free from its seat, breaking the holding pressure when the valve instantaneously falls by gravity to the full open position. This construction ensures immediate full-bore discharge up to the moment of reclosing and also reduces valve wear to a minimum by eliminating the possibility of wire drawing and grinding action on the valve face by the transmission of surging movements of the bucket through the lever. This trap is made by The Drayton Regulator and Instrument Co., Ltd.

Traps Working at any Angle

A feature of the steam traps made by the Key Engineering Co., Ltd., is one which, unlike most traps, will work at any angle within a considerable divergence from the horizontal and vertical positions which are normally necessary for mechanically operated drain traps. This design is specially useful for ships, which in a seaway are continuously altering their position relative to the horizontal, and under a considerable degree of list such traps always operate efficiently and remain steam tight.

So far these traps have only been fitted to steam ships, but the application of these traps, however, may also be extended for special uses in steam plant lay-out where it would be desirable to fit at an awkward angle.

PIPES

A variety of pipeline requirements are offered by Crane, Ltd., including: (*a*) Pipe in exact or random lengths, also fabricated pipework; (*b*) pipe fittings, in all sizes and designs, screwed or flanged; (*c*) valves designed for almost any service and pressure; (*d*) specialties such as reducing valves, safety valves, steam traps, strainers, heating equipment and pipe-fitters' tools.

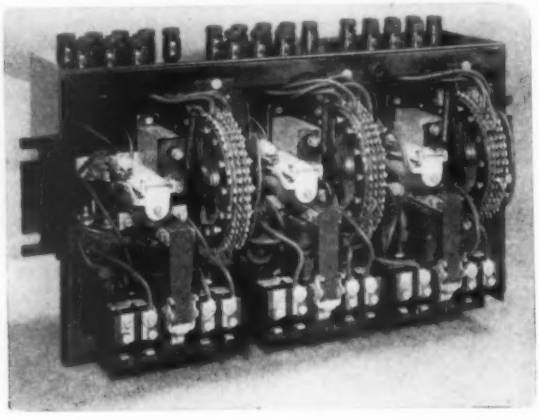
A copy of No. 10 Steam Catalogue, listing the above products, and containing much valuable data on steam and hot-water control, will be sent on request.

ELECTRIC MOTORS

Turbo-Alternators to Small Motors

Electrical apparatus for supplying power for food manufacture ranges from turbo-alternators to small electric motors, and associated apparatus such as transformers, switchgear, and control equipment is made by The British Thomson-Houston Co., Ltd.

A typical example of power generating plant with a BTH 2,000 kw. maximum rated 3,000 r.p.m. back pressure turbo-alternator (3-phase, 50 cycles, 440 volts, 0·7 power factor) has been installed in a sugar factory. Until the installation of this turbo-alternator, the power requirements of the factory were supplied by a reciprocating engine-driven generator, but it is understood that steam from the turbine is more free from oil than steam from a reciprocating engine. BTH turbo-alternators similar to this are installed in various food factories and giving excellent results.



B.T.H. Control for Soot Blower Equipment.

Electric motors find countless applications in the food industry not only for driving the machines actually used for food manufacture but for various drives in the boiler-house, and include squirrel-cage and slipring induction motors, variable speed A.C. commutator motors, power factor correction machines, geared motor units, and fractional horsepower drives. Machines are supplied with enclosures suitable for the duty for which they are used.

A development of particular interest to many engineers in the food industry is the latest type of soot-blowing equipments developed by the BTH Co. While in every way as reliable as earlier equipments, the latest type is less expensive and the control is considerably more compact, so that the floor space occupied is about halved. Very little alteration to the actual blower heads is required, as it is only necessary to fit a small limit switch and the scheme is suitable for any make of head.

The control equipment comprises a master panel for all the heads, and a control unit for each head. The standard arrangement of three control units is mounted in a dust-tight enclosing cover, which has been removed, and the compactness of the arrangement will be realised when it is known that the dimensions of this control unit for three heads are approximately 16 in. × 9 in. × 8 in. overall, while the master panel occupies about twice this space.

Totally Enclosed Fan-Cooled Motors

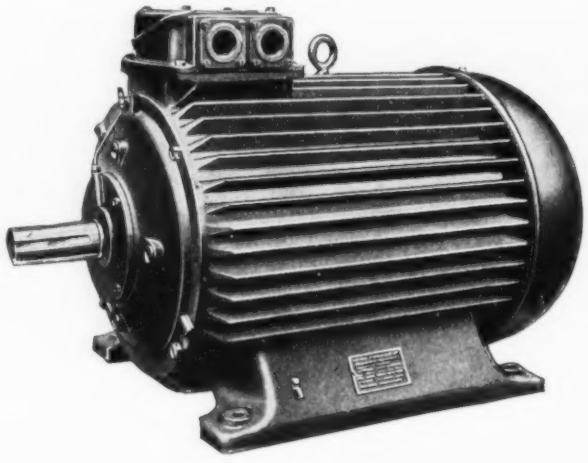
Basing their designs on experience gained with electric motors for this class of work, Bruce Peebles and Co., Ltd., have produced a complete line of totally enclosed, fan-cooled motors possessing the characteristics necessary for reliable and efficient service combined with maximum cleanliness in operation. They are simple, compact machines and embody in their design the features of the plain totally enclosed motor as regards mechanical protection, with the light weight, efficient cooling, and economy in operation which are characteristics of the ventilated type motor.

The figure shows a typical Bruce Peebles Totally Enclosed, Fan-Cooled, Squirrel Cage Motor, from which it will be noted that with the exception of the external fan and its protecting cover, the machine has no more parts than the ordinary totally enclosed motor.

Efficient cooling of an electric motor is one of the major factors in its design, and it is well known that in a totally enclosed motor it is also of prime importance to provide against "hot spots" in the windings in order to prevent carbonisation of the insulation. In Bruce Peebles motors the special design of the dual air circuits ensures uniform temperature throughout the heat generating parts and freedom from "hot spots". A high-efficiency fan gives maximum turbulence of the air, and the core seatings inside the stator frame are skewed to obtain long cooling paths for the air and the highest rate of heat transfer.

It is of interest to record that the type of winding adopted and the method of impregnating with insulating varnish ensure freedom from the possibility of trouble being experienced due to accumulation of moisture, a condition frequently met with in totally enclosed motors. Mica forms the main insulation and the materials combine great strength with heat-resisting properties.

Bruce Peebles and Co., Ltd., inform us that they will be pleased to send literature describing these machines to anyone interested.



STEAM GENERATION

Complete Plants

Installations of complete steam generating plants, either of the water-tube boiler type or shell boiler type, are undertaken by Bennis Combustion, Ltd. They also manufacture many types of mechanical stokers, pulverised fuel equipment, coal and ash handling plant of every description, bunkers (steel or reinforced concrete) and truck tippers. They also manufacture marine stokers, and have already fitted up a large number of vessels which ply between this country and America and Canada. Having had over sixty years' combustion engineering experience, they are, therefore, in a position to contract for complete plants, including foundations, buildings and all auxiliaries. Their existing contracts range from single boiler plants to large power stations, and it is interesting to note that they have installed their equipment in a large number of food factories all over the country. Their slogan is "Cheap Steam", and the food factories we have now just mentioned have reaped great economy in fuel and at the same time have been given clean boiler-houses.

PRE-HEATED AIR PLANT

The "Eske" Patent Pre-heated Air Plant (made by Industrial Combustion, Ltd.), one of the most progressive developments in industrial steam-raising plants, achieved its aim of highest efficiency and capacity, at low maintenance and installation costs, accompanied by the incalculable value of brought independence of any special sized or graded coal and coke. This is one of its main features, to ensure with any available fuel results hitherto unobtainable. The fact of being independent of any special type and sized fuel, in these days, is of specific significance, which ought not to be overlooked or underestimated. To quote some results achieved on various fuels in a recent installation, on a Lancashire boiler plant at a cloth printing works, with a view to being able to burn any available type of fuel such as washed fines, washed peas and nuts, coke and coke breeze, etc. To raise the output of the boilers, to increase the efficiency, to eliminate smoke and grit, these requirements have been fulfilled, whereby the steam costs per thousand gallons have been reduced in the region of 4s. (from 16s. to 12s. per 1,000 gallons). The capacity of the boilers has been increased in the region of 35 per cent. under normal working conditions, without any additional labour, and fuel hitherto impossible to use is utilised to-day.

ESKE SYSTEM ON FIVE LANCASHIRE BOILERS

REFUSE DISPOSAL

Most factories make arrangements to have their refuse carted away. This method is expensive and, in a food factory, particularly unhealthy, as the refuse which is accumulated for collection encourages rats, mice, flies, and all other kinds of vermin; putrefaction sets in if the rubbish is not disposed of frequently.

It is most hygienic to consume the refuse, as it is produced, in an incinerator, which can either be placed in the boiler-house and connected to the existing chimney, or placed outside the factory in any convenient spot. All kinds and quantities of rubbish can be destroyed without nuisance from smell, and a dust-catcher can be fitted to prevent the escape of charred scraps and dust. The savings effected by the elimination of cartage charges will quickly repay the cost of the plant.

By incorporating a boiler in the incinerator the heat generated in the furnace can be used to produce either steam or hot water, thus reducing the fuel consumption on the main boilers and increasing the savings effected by the incinerator.

The amount of steam or hot water which can be obtained depends upon the quantity and calorific value of the rubbish. The illustration shows an incinerator burning 1½ tons of general rubbish per eight hours. The boiler produces 600 lb. of steam per hour and saves 6 cwt. of coal per day.

Plants of this kind have been installed by the Incinerator Co., Ltd., in bakeries, biscuit, mineral water, pickle, bacon, butter and sweet factories, and dairies, etc. They would be pleased to send a detailed catalogue on request.

GASEOUS FUEL PLANT

Fuel economy is the basic feature of the plants manufactured by Henry Balfour and Co., Ltd., for the manufacture of gaseous fuels. Our carburetted and water gas plants provide a most economical method of increasing the fuel supplies.

It is said that true fuel economy should be considered as part of the greater problem of smoke abatement, and in the case of a solid fuel such as coal be attained by the gassification of the fuel and subsequent recovery of the maximum available by-products.

On this conviction the firm have built up their establishment and manufacture all types of Gas Works and Coke Oven by-product plants.

In these manufactures they have also evolved plants for economical working which materially influence fuel economy. The conservation of fuel is of immediate importance and will, no doubt, merit considerable attention in the near future.

Smoke Prevention

Natural and Forced Draught Furnaces, Smoke Prevention Firebridge, Firebars and Cradle Grate Incinerator are among the specialities made by the Halliwell Furnace and Engineering Co., Ltd. They claim for their firebars exceptional durability, and are able to supply them for a total grate area of 50 sq. feet and over that will compare favourably with the cost of ordinary firebars, with an efficiency of 10 to 15 per cent. greater. The firm's "Effecto" furnace is designed to burn any type of fuel without smoke and is adaptable to all types of boilers.

INFORMATION AND ADVICE

Saccharate of Lime—Cheese Mixer—Coffee Substitute—Information Supplied

Saccharate of Lime and Shortenings

6,080. *I write to ask if you can put me in touch with suppliers of an edible material known in Germany by the name of Zucker-Kalk. It appears that the best English translation of the name is saccharate of lime or sugar of lime. It was formerly obtainable from manufacturing chemists in Germany, but similar firms in England appear not to be able to supply it.*

While writing I would ask if you can give me any formulæ for the manufacture, on a commercial scale, of "Puff Pastry Fat"—i.e., *the fat used as shortening in making flaky puff pastry.*

Further, can you please recommend any books giving particulars of the compositions and methods of manufacture of all types of shortening fats? Is there any literature available to show the respective merits of the use of animal fats and vegetable fats in shortenings?

From the point of view of shortening value, and apart from considerations of cost, is there any reason why a hydrogenated whale oil of a given consistency and melting point should be given preference over hydrogenated cottonseed or palm oil of equal consistency and melting point, in compounding a shortening?

Saccharate of Lime: We got into touch with manufacturers who would undertake to supply this. (Name given.)

Shortenings: The references to the shortening powers of fats are very disseminated over the literature, and we cannot trace any specific book on the subject of vegetable-shortening other than *The American Vegetable Shortening Industry*. This book was published in 1934 for the Stanford Food Research Institute. It could be obtained from America for you at an approximate cost of 27s. Other than this there is Martin's *Oils, Fats and Waxes* or Dr. Clayton's *Margarine*.

Cheese Mixer

6,081. *I am experimenting with a product in which I use about 25 per cent. cheese and 25 per cent. margarine. How can I incorporate the cheese so that the product will have a smooth texture? At present I warm the grated cheese with the margarine and then smooth the two together with a knife. Can I soften hard cheese in a more convenient way, or buy a soft cheese (softer than Kraft), or use a grinding machine of some kind? I wish to start production on a small scale so as to try the product on the market as soon as possible.*

We would suggest that you obtain a mixing machine fitted with a mincer similar to a meat mincer. By this means the cheese may be made pliable and, mixed with the margarine in the mixer, will result in the product desired.

The name and address of a firm which would be able to supply the exact piece of plant needed was given.

Coffee Substitute

6,153. *Would you please supply me with information regarding any cereals from which a coffee substitute may be obtained, and method of obtaining it?*

This product is for preparation in Spain, where in substitution of coffee they are employing common roasted barley. I would like to know whether there is any other product or method that would give better results.

We would refer you to British Patent No. 436,116, which deals with the preparation of malt coffee from three- to six-days-old green barley malt or from moistened cured malt.

Information Supplied

6,220. *We were very interested in the article on "Surplus Apples in War Time" in your issue of October 6, 1939, and should be very glad if you could put us into touch with the Food Investigation Board mentioned therein, as we should like to follow the matter up further.*

Address was supplied.

6,170. *We shall feel much obliged if you can furnish us with any names of firms selling creamed sugar wafers for use as centres of chocolate-covered biscuits.*

Name of firm given.

6,144. *We are enclosing samples of wafers which we use in very large quantities. Can you recommend us to any firm in this country who would be likely to supply these?*

Name of English firm supplied.

6,225. *In your issue of February 23, 1940, you referred to a machine for peeling onions, which is being experimented on by an English firm. We should be obliged if you could give us further information.*

The name of the firm was given.

6,243. *We should like to get in touch with some of the largest manufacturers of glue in the British Isles. If you can furnish us with names and addresses, we should be extremely obliged.*

Information was supplied.

6,154. *Please let us have the address of the manufacturers of various types of vegetable cutting and dicing machines.*

Name and address given.

6,174. *Would you be so good as to give me the name of the English agent of "Koroseal"?*

Name and address supplied.

LATEST PATENTS

Owing to extreme pressure upon space the Patents page is unavoidably held over until next issue.